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THE  
**ARTIST & TRADESMAN'S GUIDE;**

EMBRACING SOME

**LEADING FACTS & PRINCIPLES OF SCIENCE,**

AND

**A VARIETY OF MATTER ADAPTED TO THE WANTS**

**OF THE**

**ARTIST, MECHANIC, MANUFACTURER,**

AND

**MERCANTILE COMMUNITY:**

TO WHICH IS ANNEXED AN

**ABSTRACT OF TONNAGE, DUTIES, CUSTOM-  
HOUSE TARES, ALLOWANCES, AND  
USEFUL MENSURATION TABLES.**

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Commerce and Manufactures—the main anchor of a nation.

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**THIRD EDITION,**

**WITH ADDITIONS AND IMPROVEMENTS.**

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**NEW-YORK:**

**PRINTED BY J. C. JOHNSON,**

**1829.**

Northern District of New-York, to wit :

BE IT REMEMBERED, That on the eighth day of November, in the fifty-first year of the independence of the United States of America, A. D. 1827, *John Shepard*, of the said district, hath deposited in this office the title of a book, the right whereof he claims as proprietor, in the words following, to wit.

"The Artist and Tradesman's Guide ; embracing some leading facts and principles of science, and a variety of matter adapted to the wants of the artist, mechanic, manufacturer, and mercantile community. To which is annexed an abstract of tonnage, duties, custom-house tares and allowances. Commerce and manufactures—the main sheet anchor of a nation."

In conformity to the act of the Congress of the United States, entitled "An act for the encouragement of learning, by securing the copies of maps, charts, and books, to the authors and proprietors of such copies, during the times therein mentioned ;" and also to the act entitled "An act supplementary to an act entitled 'An act for the encouragement of learning, by securing the copies of maps, charts, and books, to the authors and proprietors of such copies during the times therein mentioned,' and extending the benefits thereof to the acts of designing engraving, and etching, historical, and other prints."

R. R. LANSING,  
Clerk of the District Court of the United States,  
for the Northern District of New-York



## ADVERTISEMENT TO THE SECOND EDITION.

IN presenting the American Public with this Edition, it is not presumed, after the care and labour bestowed, that it is free from error or defect, but it is hoped that the errors are not material, or deficiencies more numerous, than works of a similar nature and size, which do not admit of perfection.

As the work is designed more particularly to interest the MERCHANT and MECHANIC, it is believed it will be found in its present form more worthy of their patronage.

To render it practically useful, rather than to make a display of science and fine writing, has been our greatest object.

The reception which the work has already experienced calls for the expression of the authors gratitude.

NUMEROUS testimonials in its favour might be inserted, if they were deemed necessary in accelerating the sale, but in this age of inquiry and improvement, most minds are capable of erecting a standard of discrimination, whereby they can determine in regard to the merits of a Work without the aid or recommendation of others. Nevertheless, it may not be improper to advert to the fact that the first edition was disposed of in a very few weeks after its publication.

FINALLY, if the Merchant and Mechanic are benefitted by our exertions, and we have the vanity to believe that they will be, we have not "laboured for nought," but shall reap a rich reward in the reflection that we have, in any degree, been useful to those classes of community who are the bone and sinews of our republic. To them we commit, without further remark this little manual.

THE AUTHOR.

AUGUST, 1829.

## WEIGHTS AND MEASURES.

1 Gallon measure contains	8 pints,
8 pints	16 ounces,
1 ounce,	8 drachms,
1 drachm,	60 minims.

### WEIGHT OF DRY SUBSTANCES.

1 pound contains	12 ounces,
1 ounce,	8 drachms,
1 drachm,	60 grains,
1 scruple,	20 grains.

It is customary to distinguish quantities of fluid from dry substances, by prefixing the letter *f.* (fluid) when an ounce or drachm is mentioned in medical works ; but in the formulas in this work, it was considered unnecessary, as the slightest acquaintance with the substances to be used will point out what is implied. The reader will also understand that the letters *q. s.* or *q. p.* are used to imply (sufficient or proper quantity ;) *pp.* or *ppd.* (prepared or previously prepared.)

# THE ARTIST & TRADESMAN'S GUIDE.



## CHAPTER I. INTRODUCTION.

TO the Manufacturer, Chemistry has lately become fruitful of instruction and assistance. In the arts of brewing, tanning, dying, and bleaching, its doctrines are important guides. In making soap, glass, pottery, and all metallic wares, its principles are daily applied, and are capable of a still more useful application, as they become better understood. Indeed every mechanic art, in the different processes of which heat, moisture, solution, mixture or fermentation is necessary, must ever keep pace in improvement with this branch of philosophy. Finally, there is scarcely an art of human life, which the science of chemistry is not fitted to subserve; scarcely a department of human inquiry, either for health, pleasure, ornament, or profit, which it may not be made in its present improved state, eminently to promote. To illustrate the science fully, in all its parts, would require more pages than this work is designed to contain; therefore, we shall be confined to some of the leading principles, and most useful practical operations, which it embraces.

## CHAPTER. II.

*General principles of Chemistry—Simple Substances—Compound Bodies—Attraction.*

THE science of Chemistry naturally divides itself into three parts; a description of the component parts of bodies, or of *elementary* or simple substances as they are called,—a description of the compound bodies formed by the union of simple substances, and an account of the nature of the power which produces these combinations. This power is known in chemistry by the name of affinity, or chemical attraction. By simple substances is not meant what the ancient philosophers called elements of bodies, as fire, air, earth, and water, nor particles of matter incapable of farther diminution or division. They signify merely, bodies that have never been

decomposed or formed by art. The simple substances of which a body is composed are called the *constituent* parts of that body; and in decomposing it, we separate its constituent parts. If, on the contrary we *divide* a body by cutting it to pieces, or even by grinding it to the finest powder, each of these small particles will consist of a portion of the general constituent parts of the whole body; these are called the *integrant* parts. *Compound* bodies are formed by the combination of two or more simple substances with each other. Attraction is that unknown force which causes bodies to approach each other. Its most obvious instances are the gravitation of bodies to the earth; that of the planets towards each other, and the attractions of electricity and magnetism. But that attraction which comes under the more immediate cognizance of chemists, subsists between particles of bodies; and when it operates between particles of the same species, it is called the attraction of *cohesion*; or the attraction of aggregation; but when between the particles of different substances, it is called the attraction of composition, chemical attraction, or chemical affinity. The attraction of cohesion, then, is the power which unites the *integrant* particles of a body: the attraction of composition, that which combines the constituent particles. When particles are united by the attraction of cohesion, the result of such a union is a body of the same kind as the particles of which it is formed; but the attraction of composition, by combining particles of a dissimilar nature, produces compound bodies quite different from any of their constituents. If, for instance, you pour upon a piece of copper, placed in a glass vessel, some of the liquid called nitrous acid, (aqua fortis) for which it has a strong attraction, every particle of the copper will combine with a particle of the acid, and together they will form a new body, totally different from either the copper or nitrous acid. If you wish to decompose the compound which you have thus formed, present it to a piece of iron, for which the acid has a stronger affinity than for copper, and the acid will quit the copper to combine with the iron, and the copper will be then what the chemists call *precipitated*, that is to say, it will be thrown down in its separate state, and reappear in its simple form. In order to produce this effect, dip the blade of a knife into the fluid, and when you take it out, you will observe, that instead of being wetted with a bluish liquid, like

that contained in the glass, it will be covered with a thin coat of copper.

It will be most conducive to science to consider all those substances as simple, which no mode of decomposing has yet been discovered. Simple substances naturally divide themselves into two classes. Those which belong to the first class are of too subtile a nature to be confined to any vessels which we possess. They do not seriously affect the most delicate balance, and have received therefore the name of *imponderable* bodies. The second class of bodies may be confined in proper vessels, may be exhibited in a separate state, and their weights or other properties may be determined. They have received the name of *ponderable* bodies. The imponderable bodies at present supposed to exist are four, light, heat or caloric, electricity, and magnetism. The first three are intimately connected with chemistry, but magnetism has with it no known connexion.

### CHAPTER III.

*Caloric—Sensible Heat—Latent Heat—Thermometer—Boiling Heat—Blood Heat—Interesting Experiments.*

CHEMISTS have agreed to call the matter of heat *Caloric*, in order to distinguish it from the sensation which this matter produces. Caloric has a tendency to diffuse itself equally among all substances that come in contact with it. If the hand be put upon a hot body, part of the caloric leaves the hot body, and enters the hand; this produces the sensation of *heat*. On the contrary, if the hand be put upon a cold body, part of the caloric contained in the hand leaves the hand to unite with the cold body; this produces the sensation of *cold*. Cold therefore is nothing but a negative quality, simply implying the absence of the usual quantity of caloric. Caloric is uniform in its nature; but there exist in all bodies, two portions very distinct from each other. The one is called *sensible* heat, or free caloric; the other *latent* heat, or combined caloric. Sensible caloric is the nature of heat disengaged from other bodies, or, if united, not *chemically* united with them. *Latent* caloric is that portion of the matter of heat, which makes no *sensible* addition to the temperature of the bodies in which it exists. Wrought iron, though quite cold, contains a large portion of *latent* caloric; and if it be

briskly hammered for some time on an anvil, it will become red hot, by the action of this species of caloric, which by the percussion of hammering is now evolved and forced out as *sensible* heat. Caloric pervades all bodies; and this is not the case with any other substance with which we are acquainted. It combines with different substances, however, in very different proportions; and for this reason one body is said to have a greater *capacity* for caloric than another. When gaseous substances become liquid, or liquid substances solid, by this change of state, they lose in a great measure their capacity for caloric. During the slacking of quick lime, the caloric which is involved escapes from the water, in consequence of its changing from a liquid to a solid form, by its union with the lime. When solid bodies become liquid or gaseous, their capacity for caloric is proportionably increased. If you place a glass of water in a mixture of equal quantities of snow and salt, during their conversion to a liquid, the water will be frozen in consequence of parting with its caloric to supply the increased capacity of the mixture. The portion of caloric necessary to raise a body to any given temperature, is called *SPECIFIC* caloric. The instrument in common use for measuring the temperature of bodies, is called a thermometer. Fahrenheit's is generally used in the United States. When a thermometer is brought in contact with any substance, the mercury expands or contracts till it acquires the same temperature; and the height at which the mercury stands in the tube, indicates the exact temperature of the substance to which it has been applied. It will not show the absolute caloric in substances; for it cannot measure that portion which is latent, or chemically combined with any body. Caloric is the cause of fluidity in all substances capable of becoming fluids, from the heaviest metal to the lightest gas. It insinuates itself among their particles and invariably separates them in some measure from each other. Thus ice is converted into water, and by a further portion of caloric into steam. We have reason to believe that every solid substance on the face of the earth might be converted to a fluid of a very high temperature in peculiar circumstances. Some bodies give out their superabundant caloric much sooner than others. Iron is a quicker conductor of caloric than glass, and glass than wood. If you take a piece of iron in one hand, and a piece of wood in the other, the iron feels cold, the wood

warmer, though the thermometer shows that their temperature is the same. Substances usually become more dense by the loss of caloric; but the freezing of water is a striking *exception* to this general law of nature, and is a memorable instance of the wisdom and provident care of the Almighty, when he established the laws of the universe.

Abstract caloric from steam until but 212 degrees remain, according to Fahrenheit's scale, and it will become water. Take away 180 degrees more, leaving but 32, and it will become ice. All gases and liquids would become solids, if caloric were abstracted to a certain degree, till at length all things would become permanently solid as the oldest primitive rocks.

Water requires but 212 degrees of heat for converting it into vapour: it has been made to boil at 67 degrees, which is 31 below blood heat. Therefore it requires 145 degrees of heat to resist the pressure of the atmosphere. From the following experiment we are taught, that combined caloric does not excite the sensation of heat, nor affect the thermometer: Put a piece of tinder in the end of the piston of a fire syringe, made of cotton cloth dipped in a very strong solution of salt petre, and well dried—force down the piston suddenly and the tinder will take fire. Caloric was combined with the air in the syringe before it was compressed, which did not excite the sensation of heat nor inflame the tinder. There is so much caloric in the combination of air, water and other substances about us, that if it were capable of producing the ordinary effects of heat, the whole human family would be burned in a day. From the principle that caloric expands solids as well as gases, the variation in length of pendulums of clocks and balance wheels of watches, according to the varying temperature of the weather, causing them to run faster in cold and slower in hot weather, can be accounted for.

That caloric expands liquids is clearly demonstrated by the facts, that spirits gauge more in warm, and less in cold weather. The experiment may easily be tried by placing a barrel of rum in the sun, nearly full; if the thermometer ranges high, the liquor will soon run over. Then place it in a cold cellar, let it remain awhile, and the reverse will be evident.

An iron stove quickly gives off caloric heat into a room, and as soon cools. A brick Russian stove, must be heated a great while before it begins to give off caloric, and will not cool in a long time. Clothes made of wool and silk are slow conductors of caloric; those made of flax conduct rapidly—stone is a better conductor of caloric than brick. A stone house has its rooms sooner heated in summer and cooled in winter, than a brick house. A white earthen tea pot will keep tea hot longer than a black one—a bright tin coffee pot will keep coffee hot longer than a japanned one. We are kept cooler in summer with light coloured clothes and warmer in winter, than with those which are dark coloured; for our bodies being warmer than the air in cold weather, caloric passes out through our clothes, but the hot rays of the sun in summer pass through our clothes inwardly.

## CHAPTER IV.

*Water—Solid or ice—Liquid or water—Vapour or Steam—in a state of Solidity in Marble—in Crystals—in Spars—in Gems—in Alkaline and Metallic Salts—in Mortar—Cements—Plaster of Paris.*

Water is composed of 88 parts by weight of oxygen, and 12 of hydrogen in every 100 parts of the fluid. It is found in four states, namely: solid, or ice; liquid, or water; vapour, or steam; and in a state of composition with other bodies. Its most simple state is that of ice, and the difference between liquid water or vapour and ice, is merely that the water contains a larger portion of caloric than ice, and that vapour is combined with still a greater quantity than water. However long we boil a fluid in an open vessel we cannot make it in the smallest degree hotter than its boiling point, for the vapour absorbs the caloric, and carries it off as it is produced. It is owing to this that all evaporation produces cold. An animal might be frozen to death in the midst of summer by repeatedly sprinkling ether upon him, for its evaporation would shortly carry off the whole of his vital heat. Water thrown on burning bodies acts in the same way—it becomes in an instant converted into vapour, and by thus depriving them of a large portion of their caloric, the fire, as we term it, is extinguished. Vapour occupies a space eight hundred times greater than it does when in the form of water—and the expansive force of steam is found by experiment to be much greater than that of gun powder. There is no reason to disbelieve that in time, steam may be applied to many useful purposes of which we have no idea.

Water is said to be in a state of *composition* with other bodies, because in many cases it becomes one of their *component* parts. It is combined in a state of solidity in marble, in crystals, in spars, in gems, and in many alkaline, earthly, and metallic salts, both natural and artificial, to all of which substances it imparts hardness, and to most of them transparency. Near the poles water is always solid; there, it is similar to the hardest rocks, and may be formed by the chisel of the statuary, like stone. It becomes still more solid in the composition called mortar, and in cements, having parted with more of its caloric in that combination than in the act of freezing. If you take some ground plaster of Paris, fresh



calcined, and mix it with a little water, the affinity of the plaster for the water is so great, that in a few minutes the whole will be converted to a solid.

## CHAPTER V.

*Earths and Alkalies—Silex or pure Flint—Alumine—Lime—Potash and Soda—Ammonia—Argillaceous and Calcareous Earth.*

EARTHS are such incombustible substances as are not ductile, are mostly insoluble in water or oil, and preserve their constitution in a strong heat. Notwithstanding the varied appearance of the earth under our feet, and the mountainous parts of the world, whose diversified strata present to our view substances of every texture and shade, the whole is composed of only nine primitive earths; and as three of these occur but seldom, the variety produced by the other six becomes the more remarkable. One of the most valuable earths with which we are acquainted is silex or pure flint. It is the most durable article in the state of gravel for the formation of roads. It is a necessary ingredient in earthen ware, porcelain and cements; it is the basis of glass, and of all nitrous substances. It is white, inodorous, and insipid, in its pure state, and the various colours which it assumes in different substances, proceed from the different ingredients with which it is mixed. Alumine obtained its name from its being the base of the salt called alum. It is distributed over the earth in the form of clay, and on account of its aptitude for moulding into different forms and its property of hardening in the fire, is employed for various useful purposes. In making earthen ware, a due proportion both of silex and alumine are necessary; for if alumine alone were used, the ware could not be sufficiently burnt without shrinking too much, and even cracking; and a great excess of silex would lessen the tenacity and render the ware brittle. Lime is never found pure in nature; it is obtained by decomposing calcareous matters by the action of fire, which deprives them of their acid. In its pure state it is used in many of the arts. It is employed by the farmers as a manure; and by bleachers, tanners, iron-masters and others in their several manufactures, and in medicine. The use of lime in agriculture may be attributed to its property of hastening the dissolution of all vegetable and animal matters, and of imparting to the soil a power of re-

taining a quantity of moisture necessary for the nourishment and vigorous growth of the plants. Magnesiä, besides being the basis of several salts, is of great use in medicine; and is employed by the manufacturers of enamels and porcelain. The alkalies are distinguished by an acrid and peculiar taste, they change the blue juices of vegetables to a green, and the yellow to a brown, and have the property of rendering oil miscible with water. They form various salts by combination with acids, act as powerful caustics, when applied to the flesh of animals, and are soluble in water. Potash and soda have been called fixed alkalies, because they will endure a great heat without being volatilized; and yet in a very high temperature they are dissipated in vapour. They are compounds of metallic substances, called potassium, sodium and oxygen. They have various uses in surgery and medicine, and are employed in large quantities by the glassmaker, the dyer, the soapmaker, the colourmaker, and by many other manufacturers. Ammonia is so extremely *volatile* as to exhale at all known temperatures. When combined with carbonic acid, it takes a concrete form, and a beautiful white colour, and is known in commerce by the name of volatile salts. With muriatic acid it forms what is termed sal ammonia, which is employed in many of our manufactures, particularly by dyers, to give a brightness to certain colours. In tinning metals it is of use to cleanse the surfaces, and prevent them from oxydizing by the heat which is given to them in the operation. Ammonia is furnished from all animal substances by decomposition. The horns of cattle, especially those of deer, yield it in abundance, and it is from this circumstance that a solution of ammonia in water has been termed hartshorn.

Besides the nine earths above enumerated, we have now thorina, which is a raw earthy substance lately discovered. A new alkali, called lithia, has recently been discovered, which, like potash and soda, is found to be a metallic oxide; its base is called lithium. Three new vegetable alkalies have also been discovered, called morphia, picrotoxine, and vanqueline. Clay, as it exists in soils is commonly called argillaceous earths, and lime in soils is called calcareous earth.

## CHAPTER VI.

*Acids and salts—Sulphuric, Carbonic, and Muriatic Acid—Crystalized Salts—Chalk—Limestone—Marble—Plaster of Paris—Muriate of Lime—Magnesia and Soda—Ni-*

*trate of Potash—Phosphate of Lime—Salt Mountains.*

THE name acid, in the language of chemists, has been given to all substances, whether liquids or solids, which produce that sensation on the tongue which we call sour. Most of the acids owe their origin to the combination of certain substances with oxygen; and they have the property of changing the blue, green, and purple vegetables to red, and of combining with alkalis, earths, and metallic oxides, so as to compose the compounds termed *salts*. The acids were formerly divided into three classes, mineral, vegetable, and animal; but the more useful and scientific way of dividing them, is into two classes only. The undecomposable acids, and those which are formed with two principles, are comprised in the first class; while those acids which are formed with more than two principles compose the second class. Sulphuric acid, in commerce called oil of vitriol, is procured by burning sulphur in contact with some substance containing oxygen, and becomes acidified. That peculiar acid which is called muriatic is usually obtained from muriate of soda, which is the chemical name of common salt. Carbonic acid is a combination of carbon and oxygen, formerly called fixed air, on account of its being intimately combined in chalk, brimstone, and other substances. (See the article carbonic acid gas.) The number of acids that are well known amount to more than forty, and their uses are so many and important, that it is impossible to name them. They are indispensable to various arts and manufactures; they are employed for culinary purposes, and for medicine; they act an important part in the great laboratory of nature, and form a great proportion of the mountainous districts of the globe in their various combinations. The precise number of the salts is not known, but they probably amount to more than two thousand. The different salts are known from each other by the peculiar figure of their crystals, by their taste, and other distinctive or specific characters. Their crystalization is owing to the abstraction of the heat or water by which they were displaced. Crystalized salts are liable to changes in their appearance by exposure to the atmosphere. Some have so great an affinity for water, that they absorb it with avidity from the atmosphere, and thus becoming moist or liquid they are said to deliquesce. Others having less affinity for water than atmospheric air has, lose their water of crystalization by exposure,

and readily fall into powder. Such salts are said to effloresce. Salts have not only the property of dissolving in water, but by exposure to great heat they will melt; and they require different degrees of heat to put them into a state of fusion, as well as different quantities of water for their solution. Many of the salts are to be found native, and the carbonates, sulphates, and the muriates, are the most frequent. Chalk, limestone, and marble, are all included in the term carbonate of lime. Few salts are more copiously disseminated than the sulphate of lime, particularly in the city of Paris, and hence its name, plaster of Paris. Of the native muriates, muriate of lime occurs with rock salt, and muriate of magnesia occurs in abundance in sea water; and muriate of soda not only exists in immense quantities in the ocean, but vast mountains in different parts of the world, are entirely formed of this salt. Nitrate of potash, known by the more familiar name of nitre or salt petre, is collected in various parts of the globe. Phosphate of lime which is the basis of animal bones, exists native in Hungary, and composes several entire mountains in Spain. Mountains of salt were probably formed in very remote ages, and by processes of which we can form no idea. It may be supposed, however, that the changes have been slow and gradual; for several of the native salts exhibit marks of regularity and beauty in their crystalization, which cannot be imitated by art.

## CHAPTER VII.

*Simple Combustibles—Light and Caloric—Hydrogen—Sulphur—Phosphorus—Carbon—Carburetted Hydrogen—Accidents to Miners—Curious Experiments—Cast Iron—Wrought Iron—Steel—Classification of simple Bodies.*

Most of the simple substances are combustible, or bear some relation to combustion. Light and caloric are evolved during combustion. Oxygen is the principal agent; and hydrogen, sulphur, phosphorus, carbon, and the metals are the subjects, or instruments of this process. Hydrogen gas may be combined with water, sulphur, phosphorus or carbon. When combined with phosphorus it forms phosphuretted hydrogen gas, which takes fire when it comes in contact with atmospheric air. The elastic substance called carburetted hydrogen gas, is carbon dissolved in hydrogen, it has also been called heavy inflammable air. It is this gaseous compound which has occasioned so many dreadful accidents

to miners, who call it fire damp. It is procured from pit coal by dry distillation, and from its inflammability and brilliant flame, it has been used for lighting streets, shops, manufactories and light houses on the sea coast. The rate at which it is obtained is comparatively trifling compared with oil and tallow.

Phosphorus is a solid inflammable substance, which burns at a very low temperature when in contact with oxygen gas or atmospheric air. Many amusing experiments can be performed with it; but it must be handled with extreme caution. If you fix a piece of solid phosphorus in a quill, and write with it upon paper, the writing in a dark room will appear beautifully luminous. If the face or hands be rubbed with phosphuretted ether, they will appear in a dark place as though on fire, without danger or sensation of heat. Pure carbon is known only in the diamond; but carbon in a state of charcoal may be procured by heating to redness a piece of wood closely covered with sand in a crucible, so as to preserve it while in the fire, and afterwards, while cooling, from the action of the atmosphere. It is capable of forming various combinations, but charcoal is that with which we are most familiar. Carbon is not only a component part, but it forms nearly the whole of the solid basis of all vegetables, from the most delicate flower in the garden, to the huge oak of the forest. It not only constitutes the basis of the woody fibre, but is a component part of sugar, and of all kinds of wax, oils, gums, and resins, and of these again how great is the variety! It is imagined that most of the metals may be combined with carbon; but at present we know of only its combination with iron. In one proportion it forms cast-iron, in another steel, and in a third plumbago, generally, though improperly called black lead. There is no lead in its composition. Cast iron contains about one forty-fifth of its weight of carbon. Steel is combined with about one part of carbon in two hundred of iron, and plumbago, or carburet of iron, has been found to consist of nearly nine parts of carbon to one of iron. Wrought iron differs from cast iron, in being deprived of its carbon and oxygen, by continued heat and repeated hammering, which renders the metal malleable. Steel is made of wrought iron, by various processes, whereby the metal resumes a small portion of the carbon, and acquires a capacity of receiving different degrees of hardness. The metals are generally procured from beneath the surface of the

earth, in a state of combination either with other metals, or with sulphur, oxygen or acids; though a few of them have been found in a state of purity. Metals are the great agents by which we can examine the recesses of nature; and their uses are so multiplied, that they have become of the greatest importance in every occupation of life. They are the instruments of all our improvements, of civilization itself, and are even subservient to the progress of the human mind towards perfection. They differ so much from each other, that nature seems to have had in view all the necessities of man, in order that she might suit every possible purpose his ingenuity can invent or his wants require. We not only receive this great variety from the hand of nature, but these metals are rendered infinitely valuable by various other properties which they possess;—by their combustibility, their solubility in fluids their combinations with various substances, and by their union with each other, whereby compound and alloys are formed, extremely useful in a variety of arts, manufactures, and other requisites of life. By combining them with oxygen we can invest them with *new* properties, and are enabled to employ them to promote the progress of the fine arts, by imitating the master pieces of creation in the production of artificial salts, gems, and crystals, of every colour and of every shade.

The following is an enumeration of the classification of the simple bodies in general. I. Comprehending the imponderable agents, Heat or Caloric, Light, and Electricity. II. Comprehending agents capable of uniting with inflammable bodies, and in most instances of effecting their combustion,—Oxygen, Chlorine, and Iodine. Many learned chemists have doubted whether chlorine and iodine were supporters of combustion, any further than they contain oxygen. They are classed among the simple bodies, because they have not as yet, been resolved into other ingredients. The name chlorine is simply expressive of its greenish colour, and iodine of its violet colour. III. Comprehending bodies capable of uniting with oxygen, and forming with its various compounds,—1. Hydrogen, forming water. 2. Bodies forming acids. Nitrogen, forming nitric acid, Sulphur, forming sulphuric acid, Phosphorus, forming phosphoric acid, Carbon, forming carbonic acid, Boron, forming boric acid, Fluorine, forming fluoric acid. 3. Metallic bodies which have been divided into the seven following classes. 1st. The metals which combine with oxygen and form alkalies. These are potassium, sodium and lithium. The volatile alkali ammonia has been found by Sir Humphrey Davy to be a triple compound of nitrogen, hydrogen and oxygen. 2. Those metals which by combining with oxygen form the alkaline earths, viz. calcium, magnesium, borium and strontium. Calcium is the base of lime, magnesium of magnesia, and so on. The metallic substances are of the colour of silver. 3. Those metals which by combining with oxygen constitute the remainder of the earths. These are

silicium, alumium, zirconium, glucinum, githrium and thorinum. These are presumed metals; for the earths, of which they are supposed to constitute the bases, have been as yet but partially decomposed; respecting some of them but little is known. 4th. The metals which absorb oxygen and decompose water at a high temperature. These are iron, tin, zinc, cadmium and manganese. 5th. Those metals which absorb oxygen at different temperatures, but do not decompose water at any temperature. This class is composed of twelve distinct metals, viz. osmium, cerium, tellurium, titanium, uranium, nickel, cobalt, copper, lead, antimony, bismuth, and mercury. 6th. Those metals which do not decompose water, but absorb oxygen and thereby convert it into acids. These are arsenic, molybdenum, tungsten, chromium, columbium and selenium. 7th. Those metals which do not decompose water, or absorb oxygen from the atmosphere at any temperature. These are platina, gold, silver, palladium, rhodium and iridium.

### CHAPTER VIII.

*Oxides and Combustion—Gas producing pleasurable sensations—Combustion defined—Interesting Experiments—Reflections.*

Any metal or combustible body, which is combined with less oxygen than is sufficient to render it *acid*, is usually called an *oxide*. Whenever a substance is converted into an oxide, we say it is oxydized. The mineral, the animal, and vegetable kingdom all furnish matters which are convertible into oxides by an union with oxygen. Metallic oxides are formed in several ways, the chief of which are by the access of atmospheric air, by the decomposition of water, and by the decomposition of acids. Iron may be mentioned as a familiar example of metals becoming oxydized by atmospheric air. It is well known; that when this metal is exposed to air and moisture it acquires rust, or in other words, its surface is converted to an oxide; in which state, the metal will be found to have acquired an increase of weight. Common red lead, which is a true oxide of lead, is made by melting that metal in ovens so constructed as to have a free access to atmospheric air. Gold, silver and platina, cannot be oxydized, unless in a very high temperature; and with respect to other metals, they not only differ in their capacity for oxygen, but also in their attraction for it, so that one will often rob the other, thus reducing the first oxide to its primitive metallic form. If you dissolve some quicksilver in nitric acid, and after dropping a little of the solution upon a bright piece of copper, gently rub it with a piece of cloth, the mercury will precipitate itself upon the copper, which will be completely silvered. W

regard to oxide of nitrogen, the first degree of oxydizement produces *nitrous* oxide; a further portion of oxygen, nitric oxide, and they are both in a state of gas. Nitrous oxide gas bears the nearest resemblance of any other to that of the atmospheric air. It will support combustion even better than common air; it is respirable for a short time, and it is absorbed by water. Persons who have inhaled this gas have felt sensations similar to that produced by intoxication. In some people it produces involuntary muscular motion, and a propensity to leaping and running; in others involuntary fits of laughter; and in all high spirits, and the most exquisitely pleasurable sensations, without any subsequent feelings of debility. (It is readily procured by exposing crystals of nitrate of ammonia, in a retort, to the heat of a lamp, by which means the ammoniacal salt is decomposed, and this gas is evolved.) Combustion may be defined to be a process by which certain substances decompose oxygen gas, absorb its base, and suffer its caloric to escape in the state of sensible heat. The agency of oxygen in combustion is attributable to its affinity for combustible bodies. The combustible having a greater affinity to oxygen than the oxygen has to caloric, the oxygen gas is decomposed, and its oxygen combines with the ignited body, which is caloric, becoming free, is diffused among the surrounding bodies. Whenever we burn a combustible body, a continued stream of atmospheric air flows towards the fire place, to occupy the vacancy left by the air that has undergone decomposition, and which, in its turn, becomes decomposed also. Hence a supply of caloric is furnished without intermission, till the whole of the combustible is saturated with oxygen. As the combustible burns, *light* is disengaged, and the more subtile parts, now converted by caloric into gas, are dissipated in that state. When the combustion is over, nothing remains but the earthy parts of the combustible, and that portion which is converted by the process, into an oxide or an acid. The smoke which arises from a common fire is chiefly water in the state of vapour, with a mixture of carburetted hydrogen and bituminous substances; part of the water comes from the moisture of the fuel; and the other part is formed during combustion, by the union of the hydrogen of the combustible with the oxygen of the atmosphere. The agency of oxygen in combustion may be demonstrated by placing a lighted candle under a glass vessel



inverted upon a plate of water. It will be seen that the candle will go out as soon as it has consumed all the oxygen contained in the included air, and that the water will rise up in the vessel to fill the vacancy. In the decomposition of atmospheric air by combustion, it is natural to ask, what becomes of the nitrogen gas? As the oxygen becomes fixed in the combustible body, its caloric is disengaged, a part of which combines with the nitrogen, and carries it off in the form of rarified nitrogen gas. When bodies are burnt, none of their principles are destroyed. We believe that every particle of matter is indestructible, and that the process of combustion merely decomposes the body, and sets its several component parts at liberty, to separate from each other, to form other new and varied combinations. It was said of old, that the Creator *weighed* the dust and *measured* the water, when he made the world. The first quantity is here still; and though man can gather and scatter, move, mix and unmix, yet he can destroy nothing; the dissolution of one thing is a preparation for the being, and the bloom, and the beauty of another. Something gathers up *all* the fragments, and nothing is lost.

## CHAPTER IX.

*Of the Gases—Experiments, useful and entertaining—Vital Air—The cause of the vermillion colour of the Blood—Gas so destructive of Life—The cause of Torrents of Rain—Inflammable Air—The Phenomena of Lights, such as are seen on damp grounds, accounted for—Fatal Accidents resulting from Carbonic Acid—Carbonated Waters, called Soda Waters—Death of Pliny, the Naturalist—To change Vegetable Colours—Contagious Vapours—To discharge Vegetable Colours—Burn Metals—Process of bleaching coloured Goods—To resemble the firing of Musketry—To produce luminous Appearances—Brilliant Sparks—Phosphorus Bottles—Matches for instantaneous Light—Artificial Volcanocs.*

**OXYGEN GAS—Vital Air.** Put a quantity of oxymuriate of potash into a small glass retort, to which is adapted a bent tube to collect the gas, and which passes beneath a bell glass filled with water; the retort is gradually heated; the air in the apparatus is expelled, the salt melts, is decomposed, and we obtain all the oxygen that enters into the composition of

chloric acid and the potash—there remains in the retort a chlorulet of potassium. One hundred grains of the oxymuriate, yields thirty-nine grains of oxygen gas:

*The Atmosphere*; is composed of two distinct substances; termed oxygen and nitrogen gas. It is not a chemical *compound*, but a mere mixture of these gaseous substances in the proportion of 21 of the former and 79 of the latter. It contains, also, about one part in every thousand of carbonic acid gas, a considerable portion of water in a state of elastic vapour, and several adventitious substances. Oxygen is an element, or simple substance generally diffused through nature; though like caloric it does not exist by itself. It takes its name from two Greek words, signifying that which produces or generates acids, because one of its general properties is to form acids by combining with different substances, which are called the bases of the several acids. Its different combinations are essential to animal life and combustion. Acted upon or combined with caloric it becomes oxygen gas, which is distinguished from all other gaseous matter by several important properties. Inflammable substances burn in it, under the same circumstances as in common air, but with vastly greater vividness. If a taper, the flame of which has been extinguished, the wick only remaining ignited, be plunged into a bottle filled with it, the flame will instantly be rekindled, and be very brilliant, and accompanied by a crackling noise. If a steel wire, or thin file, having a sharp point, armed with a bit of wood in a state of inflammation be introduced into a jar filled with the gas, the steel will take fire, and its combustion will continue, producing a most brilliant phenomenon. Oxygen gas is a little heavier than atmospheric air, and from its being absolutely necessary to the support of animal life, has been called vital air.

**NITROGEN GAS.** Phosphorus is inflamed in a given quantity of air—this gives up all its oxygen and the nitrogen is set free. For this purpose we set on fire a small bit of phosphorus, placed on a brick, which has been previously fixed on the shelf of a pneumatic trough, and which ought to be so elevated, that the phosphorus may be above the water in the trough, and, of course, in contact with the air. As soon as the phosphorus is inflamed, it should be covered with a large bell-glass full of atmospheric air, which dips into the water of the trough—the phosphorus, now in contact with the air of

the vessel, robs it of all its oxygen, forms phosphoric acid, which we see under the appearance of a very dense cloud, and a great amount of caloric and light is extricated; the air dilated by the heat which is produced, partly escapes in large bubbles; at the expiration of one or two minutes, the phosphorus goes out, and the process is terminated. The apparatus is left in the same situation, and the water is seen to rise in the bell-glass until this is cool; the phosphoric acid is completely dissolved, and the interior of the apparatus, before nebulous and very opaque, regains its transparency. The nitrogen gas, which remains above the water, ought to be shaken sometimes with that fluid to remove any phosphoric acid it may retain, and particularly to decompose a portion of phosphuretted nitrogen gas which always is formed in the process, and which, thus agitated, abandons the phosphorus. Very pure nitrogen gas can be obtained by passing a stream of chlorine gas through liquid ammonia inclosed in a bottle.

*Nitrogen* is a substance diffused through nature, and particularly in animal bodies. It is not to be found in a solid or liquid state; but combined with caloric, it forms nitrogen, or as the French chemists call it on account of its being so destructive of life, *azotic gas*, in which no animal can breathe, or any combustible burn. It is uninflamable and somewhat lighter than atmospheric air, and though by itself it is so noxious to animals, it answers an important end, when mixed with oxygen gas in atmospheric air. Were it not for this large quantity of nitrogen in the atmosphere, the stimulating power of the oxygen would cause the blood to flow with too great rapidity through the vessels; the consequence of which would be, that the life of man would not be protracted to the length it now is. The vermilion colour of the blood is owing to the inhalation of oxygen gas. When the dark purple blood of the veins arrives at the lungs, it imbibes the vital air of the atmosphere, which changes its dark colour to a brilliant red, rendering it the spur to the action of the heart and arteries, the source of animal heat, and the cause of sensibility, irritability and motion. With regard to the nitrogen that is combined with atmospheric air, the greatest part of it is thrown out of the lungs at every respiration, and it rises above the head, that a fresh portion of air may be taken in, and that the same air may not be repeatedly breathed. The leaves of trees

and other vegetables give out during the day a large portion of oxygen gas, which, uniting with the nitrogen thrown off by animal respiration, keeps up the equilibrium, and preserves the purity of the atmosphere. In the dark, plants absorb oxygen, but the proportion is small compared to what they exhale by day.

**HYDROGEN GAS.** Put a quantity of filings of zinc into a vessel which has a glass tube adapted to it, and pour upon them sulphuric acid, (oil of vitriol) diluted with six or eight times the quantity of water—an effervescence will immediately take place—the oxygen of it will immediately become united to the metal, and the hydrogen gas will be disengaged, and may be conveyed by the glass tube into any proper receiver. While it is rushing through the tube, it may be kindled with a taper, and it will burn with a long flame like a candle.

Hydrogen gas is only one fourteenth the weight of atmospheric air, and occupies a space 1500 times greater than it possessed in its aqueous combination. It is continually emitting from vegetable and animal matter during their decay, and is evolved from various mines, volcanoes, and other natural sources. From its great levity it has been used to fill air balloons. In the burning of the gas, the hydrogen unites with the oxygen of the atmosphere, and the result of the combination is flame and water. It has been supposed that torrents of rain, which generally accompany thunder storms may arise from a sudden combustion of hydrogen and oxygen gases by means of lightning. Hydrogen was the base of the gas which was formerly called inflammable air, and when in the aeriform state is the lightest of all ponderable things.

Hydrogen gas is procured by decomposing water by the galvanic battery; in this case it is extremely pure. It is also largely procured by decomposing the vapour of water made to pass over iron filings, or wire, in a gun barrel.

**NITROUS OXIDE GAS.** (See chapter vi.)

**PHOSPHURETTED HYDROGEN GAS.** Take a tin quart basin—make an inch hole through the bottom—have a tin quart decanter with straight sides, let the mouth be soldered to the under side of the basin, so that it may fit the hole in the basin—now introduce through the hole in the decanter, dry newly slacked lime, two parts mixed with one part of dry pearlshashes, occasionally pouring in a little cold water, just

sufficient for a thin paste, until it is nearly filled to the bottom of the basin—drop in two inches of a stick of phosphorus, cut into small pieces—stir the whole so as to mix all parts thoroughly—set the decanter part on coals, or suspend it over a lamp—raise a moderate heat: before the mass is to a boiling heat bubbles of the gas will appear in the neck and explode;—now fill the neck with water, and lay on the mouth a piece of lead about two inches in diameter with a hole in the centre about the size of a pipe stem. Fill up the basin with cold water, which must be occasionally changed, by dipping out when it becomes too warm. Bubbles of gas will rise to the top of the water, explode, and form an ascending corona or wreath, but they will sometimes spread over the surface, appearing very small. Break off the foot of a wine-glass and use it as a receiver for collecting and turning up large bubbles, and for transferring gases into a cistern.

By this experiment we are furnished with an exhibition resembling what is sometimes called Jack o'the lantern, frequently seen in damp grounds, where animals are putrifying.

**CARBONIC ACID GAS.** This is more destructive of life than any other, and it extinguishes flame instantaneously.—Water may be made by pressure, to absorb three times its bulk of this gas, by which it acquires an acidulous and not unpleasant taste. Soda-water, cider, and other fermented liquors owe their briskness and sparkling to the pressure of this gas. Fatal accidents often happen from the burning of charcoal in chambers, for wherever charcoal is burned, this gas is always formed. It so often occupies the bottom of wells that workmen ought not to venture into such places without previously letting down a lighted candle—if the candle burns they may enter it with safety; if not, a quantity of quicklime should be let down in buckets, and gradually sprinkled with water. As the lime slacks it will absorb the gas, and the workmen may afterwards descend in safety.

Pulverize a piece of marble—put a wine-glass full into a retort—pour on it a gill of water—when it has soaked a minute, pour in slowly half a wine glass of sulphuric acid, diluted with about five times as much water: the carbonic acid will come over in the state of gas, and can be collected in any receiver placed on a shelf of the cistern. On this principle the carbonic acid for making acidulous waters, improperly called soda water, is obtained.

Pass some of the gas into a decanter of pure cold water,

and agitate it until the water and gas are well mixed; pour into a wine-glass of it some of the blue infusion of red cabbage, and it will become a very light red colour. The infusion ought rather to be greenish when put in, by having added to it an extremely small quantity of an alkali before it is used, otherwise the change in colour made by the acidulous water will hardly be perceived. Carbonated waters, called soda waters are made upon this principle. The waters, sold under the name of soda waters, as prepared generally, contain both sulphurous acid and muriatic acid. Chalk is commonly used which contains generally a little of the muriate of soda—this being decomposed, furnishes muriatic acid—it is impossible to avoid a little mixture of sulphuric acid, used in the process. To cleanse the gas from these deleterious impurities, prepare the gas and force it through a condenser, containing a small quantity of water, before the water for use is introduced. Carbonated water, containing but about thrice its bulk of the gas, used with the syrups commonly employed makes an excellent table drink in hot weather.

**SULPHUROUS ACID GAS.** Put into a glass retort, two parts of sulphuric acid, and one of mercury, and apply the heat of a lamp; the mixture effervesces, and a gas issues from the beak of the retort, which may be received in glass jars filled with mercury, and standing in a mercurial trough. In this process, the mercury in the retort combines with the oxygen of the sulphuric acid; and the sulphuric acid, having lost a certain portion of its oxygen, is converted into *sulphurous acid*. This gas is very abundant in the environs of volcanoes. It was the vapour of sulphurous acid which suffocated Pliny, the naturalist, in that eruption of Vesuvius by which Herculaneum was swallowed up, in the year of Christ, 79—It is composed of 68 parts sulphur and 32 parts oxygen.

Sulphurous acid gas is produced by the slow combustion of sulphur. If this gas be received in water the gas combines with it, and sulphurous acid will be the result. Water at  $40^{\circ}$  absorbs one third of its weight of sulphurous acid gas.

Sulphurous acid possesses very slight acid properties. Instead of changing vegetable blues to red, as acids generally do, it invariably renders them white. Suspend a red rose within a glass jar, and in that situation expose it to the confined fumes of a brimstone match; this will soon produce

a change in its colour, and at length the flower will become quite white.

**MURIATIC ACID GAS.** Pour one part of sulphuric acid upon two parts of dry muriate of soda, in a turbulated retort, and collect the gas as it becomes disengaged, over mercury in a pneumatic apparatus. - Or, take some of the muriatic acid of commerce, heat it in a glass retort, and it may be collected as in the preceding method. Proceed as in the first experiment, but instead of collecting the gas over mercury, receive it in a vessel containing a small portion of water. By these means liquid muriatic acid will be formed. Take a small quantity of silver, or a piece of an ore containing silver, and digest it in some *purified* nitric acid, which will dissolve the whole of the silver. A single drop of muriatic acid will separate a portion of the silver in white flakes, which will fall to the bottom of the glass in an insoluble precipitate. Proceed as in the last experiment, but instead of using muriatic acid drop in a portion of common salt, which will as effectually precipitate the silver. By these means any ore may be divested of the silver it contains.

*To remove Contagious Vapours arising from the Beds of the Sick.* Remove the sick and other persons from the room—set a tea-cup or gallipot on the floor, half filled with table salt—pour into it strong sulphuric acid, and the room will be filled with muriatic acid gas—after a few minutes open the windows, and the air of the room will be purified.

*To Neutralize Animal Effluvia arising from the Beds of the Sick.* Pour a tea-spoonful of muriatic acid upon a red hot iron shovel, and then pouring a wine-glass of water upon it—the acid will rise up in the state of a suffocating gas, and the water will follow it in the state of vapour and absorb it almost instantaneously, so that the suffocating gas will wholly disappear.

**CHLORINE GAS.** Put into a retort a little black oxide of manganese in powder, and pour upon it double its weight of strong muriatic acid, connect the retort with the pneumatic trough, and receive the gas over water. When the ascension of the gas slackens, apply the heat of a lamp, and it will be disengaged in abundance. Its specific gravity is to that of hydrogen, nearly as 34 to 1.

If a small quantity of liquid oxymuriatic is wanted, it may

readily be found with a little *euchlorine*, (a compound of chlorine and oxygen; chlorous acid,) by dissolving a few grains of oxymuriate of potash, and adding the solution to an ounce of common muriatic acid. It is of a yellowish green colour, which was the cause of its being called *chlorine*. This gas cannot be breathed without great injury. It discharges vegetable colours—burns all the metals, and when combined with water, will dissolve gold and platinum: with various alkaline and earthy bases, it forms salts, called *ehlorides*. Instead of changing blue vegetable colours red; as is the case with acids generally, chlorine destroys colours. Instead of distinguishing it as one of the acids; it would be more proper to call it an acidifying principle, for it possesses few properties which characterize that class of bodies. Its taste is astringent; and, unlike the acids, is combined very sparingly with water. It has not been decomposed either by electricity or galvanism; which is presumptive proof of its being a simple substance. Its greatest use is the bleaching. The following experiment may be considered as a complete example of the process of bleaching coloured goods: if a few pieces of dyed linen cloth, of different colours be dipped into a phial of oxymuriatic acid, the colours will be quickly discharged; for there are few colours which can resist its energetic effects.

*Carburetted Hydrogen Gas.* Take some pieces of coal from a coal pit bed, or some other place, where the coal has been exposed to the weather a long time, and has become intimately combined with water; dry, pulverize, and heat it in a gun barrel; the heat must be raised gradually, for a slow heat will evaporate the water, with but very little combination. Collect the gas into the cistern, and put some into a glass-holder and burn it, when will be produced a blue flame without giving much light.

*Carburetted Hydrogen, united with Oxygen Gas.* Mix the gases in equal volumes, in a bell glass, or tumbler, pour this into a narrow mouthed bottle or decanter, sink the bottle under the water of the cistern, holding the thumb over its mouth: wet a roll of paper in spirits turpentine, light it and hold it close to the water over the bottle and let up the gas in small bubbles—when they come in contact with the blaze of the taper they will explode, which produces a noise like the firing of musketry under the water.

*Heavy Carburetted Hydrogen, or White Gas.* Take



half a gill of alcohol, put it into a deep turbulated retort, pour upon it in a small steady stream, about twice as much by measure, of strong sulphuric acid—put in the stopper, and apply the candle to the retort, approaching it gradually. Let a little of the first escape, which consists of atmospheric air and ether, collect the gas over water; if it contains considerable sulphuric acid, it will generally disappear soon, while standing over water; but lime water will purify it if necessary. Mix it with double its volume of oxygen and explode it, as directed with the carburetted hydrogen. Burn it pure in a stream, and it will give a very luminous blaze. Fill a glass cylinder, or eight ounce phial with liquid chlorine, pass this gas up into it, until about two-thirds of the liquid chlorine, is displaced. The volume of the gas will be diminished on standing a few seconds, and water will ascend. On the surface of the water will be seen oily masses resembling small drops of tallow.

*A Gas which will produce a luminous appearance.* Take an ounce phial—fill it two-thirds full of sweet oil; now insert shavings of phosphorus, half an inch of a common stick will answer—hold the phial near the fire, until nearly as hot as can be borne by the hand; keep it at this temperature till the phosphorus is melted, then take out the cork, the upper part of the phial will become luminous in the dark; let every light be extinguished in the room, and pour two or three teaspoonfuls of it in you hand—rub it thoroughly over your face and hair—the face will become exceedingly luminous—the hair exhibiting undulating flames. The phial must be warm, not hot, that the oil may have a temperature equal to blood heat when applied.

*Phosphorus*, is obtained from animal bones. The process is too lengthy to show in this work; a very small quantity is sufficient for experiments—which is easily procured at the drugg shops.

*To obtain the Oxide of Phosphorus.* Let a stick of phosphorus be exposed in water, for severals days in a phial: the outside will be covered with a white substances—this is the oxide, which is more inflammable than that which is free.

*Application.* 1. Scrape a little off, and expose it to the rays of the sun, and in a short time it will take fire.

2. By heating a phial moderately, with a pice of phosphorus attached to the end of a wire, and rubbing it about the inside

in a half melted state, so as to coat it, we obtain the oxide, or as it is sometimes called "Phosphoric coat match phial." If it is not very cold weather, by taking a little out and exposing it to the air, it will take fire and burn spontaneously. In preparing it there is danger of its taking fire, in which case the phial must be stopped until the flame is extinguished.

3. Rub a stick of phosphorus lightly on a board, and it will appear luminous in the dark. Blow on it, and undulating waves will be exhibited and vanish alternately.

4. *To produce brilliant sparks.* Place on a table, a perfectly dry earthen plate, in the centre of which lay a small piece of phosphorus; set it on fire and invert over it a half gallon turbulated bell glass, perfectly dry: raise one side a little, or place a chip under it; start the stopper of the turbulature a little, so as to permit the nitrogen gas to escape, as the oxygen of air in the glass becomes exhausted. We are thus furnished with the exhibition of a snow storm. Dry white phosphoric acid will fall on the plate; it strongly attracts water, like the other acids; it will become liquid, though corked very tight in a phial; therefore, much care is necessary to keep it perfectly tight in a phial. While the powder remains dry and undisturbed on the plate, dip a fine shaving brush into some cold water, and strike it a cross your finger, so as to sprinkle very fine drops of water on the powder, and very brilliant sparks will be exhibited.

*Phosphorus bottles.* Phosphorus two drachms, lime one drachm, mixed together, put into a closely stopped phial, and heat it before the fire, or in a ladle of sand for about half an hour.

2. Phosphorus one drachm, cera alba fifteen grains, put it into a bottle under water, and melt them together; let the water cool, and as it begins to grow solid, turn the bottle round that the sides may be coated; then pour out the water and dry it in a cool place.

*Matches for instantaneous light.* Oxymuriate of potash, flour of sulphur, each half a scrupel, vermilion two grains, a sufficient quantity of oil of turpentine to make a paste, with which coat the ends of slips of wood, previously dipped in oil of turpentine and dried; when these matches are plunged in oil of vitriol, and immediately withdrawn, they take fire instantaneously. To prevent the oil of vitriol from spilling, if the bottle should accidentally fall on one side, pour-

ded asbestos, or sand, is put in the bottle to soak up the acid.

2. Oxymuriate of potash nine grains, sugar three grains, flour of sulphur two grains, a sufficient quantity of spirits of wine; the wood to be previously primed with camphire dissolved in spirits of wine.

*Artificial Volcanoes.* Ram with force into a large pot, a paste, made of 109 pounds of iron filings, intimately mixed with 100 pounds of pulverized sulphur, and just water enough to make a dense paste. This paste is then buried to a considerable depth in the earth, and between ten and twenty hours afterwards it bursts and burns with great force. It is presumed this experiment was never tried in America. It requires a great quantity of the mixture to produce any effect. Lemery produced it with the quantity above specified.

## CHAPTER X.

*Electricity—Peculiar and Surprising Phenomena—Conductors—Leyden Phial—The cause of Lightning—Galvanism—Voltaic Pile—Experiments.*

The surface of the earth, and of all the bodies with which we are acquainted, is supposed to contain or possess a power of exhiting or exhibiting a certain quantity of an exceedingly subtile agent, called the electric fluid or power. The quantity usually belonging to any surface, is called its natural share, and then it produces no sensible effects; but when any surface becomes possessed of more, or of less than its natural quantity, it is electrified, and it then exhibits a variety of peculiar and surprising phenomena, ascribed to the power called electric. All those bodies which transmit or conduct electricity from one surface to another, are called conductors, and those surfaces which will not transmit the electric power, are called electrics or non-conductors. The general class of conductors comprehends metals, ores, and fluids, in their natural state, except air and oils. Vitrified and resinous substances, amber, sulphur, wax, silk, cotton, and feathers are electrics or non-conductors. Many of these, such as glass, resin and air, become conductors by being heated. When a surface is supposed to have more than its natural quantity of this fluid, it is said to be *positively* electrified, and when less than its natural share, to be *negatively* electrified. When any electrified conductor is wholly surrounded by non-

conductors, so that the electric fluid can not pass from it along conductors to the earth, it is said to be *insulated*. The human body is a good conductor of electricity; but if a person stand on a cake of resin, or on a stool supported by glass legs, the electric fluid cannot pass from him to the earth, and if he is touched by another person standing on the ground, a sparkling appearance and noise will be exhibited. Two surfaces, both positively or both negatively electrified, *repel* each other; and two substances, of which one is positively and the other negatively electrified, *attract* each other. Opposite electricities always accompany each other, for if any surface become positive, the surface with which it is rubbed becomes negative; and if any surface be rendered positive, the *nearest* conducting surface will become negative. When one side of a *conductor* receives the electric fluid its whole surface is instantly pervaded; but when an *electric* or *non-conductor* is presented to an electrified body, it becomes electrified on a small spot only. If to one side of a pane of glass you communicate positive electricity, the opposite side will become negatively electrified, and the plate is then said to be *charged*. These electricities cannot come together, unless a communication, by means of conductors, is made between the sides of the glass; and if their union be made through the human body, it produces an affection of the nerves called an electric shock. As the excitation which is produced by rubbing with the hand on a tube or plate of glass, is not only very laborious, but inadequate to the production of any material quantity of electric fluid, machines have been constructed of various forms for this purpose.—Some of the experiments which may be made with an electrical machine are necessary for illustrating the laws of electricity, and others are merely entertaining. If the inside of a glass tumbler be electrified by presenting it to a pointed wire, extending from the prime conductor, and then placed over a few pitch balls laid upon a table, the balls will immediately begin to leap up along the sides of the glass, and then back on the table;—they are attracted and repelled by the electrified inside surface of the glass, the electricity of which they gradually conduct to the table. If a person having long hair, not tied up, be placed upon an insulated stand, and, by means of a chain, be connected with the prime conductor, when the machine is put in motion, the hairs on his head, by repelling each other,

will stand out in a most surprising manner. A piece of sponge, filled with water, and hung to the conductor, when electrified in a dark room, exhibits a most beautiful appearance. If a piece of sealing wax be fastened to a wire, and the wire be fixed into the end of the conductor, and the wax lighted, the moment the machine is worked, the wax will fly off in the finest threads imaginable. Take a two ounce phial, half full of olive oil; pass a slender wire through the cork, and let the end of it be so bent as to touch the glass just below the surface of the oil; then place your thumb opposite to the point of the wire in the phial, and, if in that position, you take a spark from the charged conductor, the spark, in order to reach your thumb, will actually perforate the glass. In this way holes may be made all around the phial. Substances should be warmed and experiments made when the wind is northerly, and the atmosphere dry, to produce the best effect.

By means of the Leyden Phial, a hundred persons may receive a shock at the same instant, and electric fluid, on the same principle, might be conveyed many miles in a moment of time. The electric fluid may be made to appear in the form of a vivid flash, accompanied with a loud report, with this phial. But the greatest discovery that was ever made in electricity, was reserved for Dr. Franklin, of Philadelphia. Franklin brought the supposition that a similarity existed between lightning and the electric fluid to the test, and proved the truth of it by means of a boy's kite covered with a silk handkerchief instead of paper, and some wire fastened in the upper part, which served to collect and conduct the fluid. When he raised this machine into the atmosphere, he drew electric fluid from the passing clouds, which descended through the flaxen string of the kite, as a conductor, and was afterwards drawn from an iron key, which he tied to the line at a small distance from his hand; from this experiment originated the formation of a conductor to secure buildings from the effects of lightning.

When aqueous vapour is condensed, the clouds formed are usually more or less electrical, and the earth below them being brought into an opposite state, a discharge takes place, when the clouds approach within a certain distance, constituting lightning, and the collapsing of the air, which is rarified in the electric circuit, is the cause of the thunder, which is more or less intense, and of longer or shorter duration, ac-

cording to the quantity of the air acted upon, and the distance of the place where the report is heard from the point of the discharge.

**GALVANISM.** Galvanism is another mode of exciting electricity. In electricity the effects are chiefly produced by mechanical action, but the effects of Galvanism are produced by the chemical action of bodies upon each other. When it was observed, that common electricity, even that of lightning, produced vivid convulsions in the limbs of recently killed animals, it was ascertained that metallic substances, by mere contact, under particular circumstances, excited similar commotions. It was found essential that the forces of metals employed should be of different kinds. Apply one piece of metal to the nerve of the part, and the other to the muscle, and afterwards connect the metals, either by bringing them together, or connecting them by an arch of metallic substance; every time this connexion is formed, a convulsion takes place. The greatest muscular contractions are found to be produced by zinc, silver, and gold. A person may be made sensible of this kind of electric action by the following experiments: If he places a piece of one metal, as a half crown above, and a piece of some other metal, as zinc, below his tongue, by bringing the outer edge of these pieces in contact, he will perceive a peculiar taste, and in the dark will see a flash of light. If he puts a slip of tin foil upon the ball of one of his eyes, and a piece of silver in his mouth, by causing these pieces to communicate, in a dark place a faint flash will appear before his eyes. Galvani supposed that the virtues of this new agent resided in the nerves of the animal, but Volta showed that the phenomena did not depend on the organs of the animal, but upon the electrical agency of the metals, which is excited by the moisture of the animal, whose organs were only a delicate test of the presence of electric influence. The conductors of the galvanic fluid are divided into the perfect, which consist of metallic substances and charcoal, and imperfect, which are water and oxydated fluids, as the acids, and all the substances that contain these fluids. To render the Galvanic, or more properly, the Voltaic power sensible, the combination must consist of three conductors of the different classes. When two of the three conductors are of the first class, the combination is said to be of the first order; when otherwise, it is said to be of the second order. If

a piece of zinc be laid upon a piece of flannel, moisted with a solution of salt water, a *circle* of the first class is formed; and then, if three other pieces be laid on these in the same order, and repeated several times, the whole will form a pile or *battery* of the first order. The effects may be increased to any degree by a repetition of the same simple combination. The following is a cheap and easy method of constructing a Voltaic pile. Cast 20 or 30 pieces of zinc, of the size of a cent; take as many cents and as many pieces of paper or woollen cloth cut in the same shape, and dip in a solution of salt and water. In building the pile, place a piece of zinc, then wet paper, the superabundant water being pressed out, after which the copper; then zinc, paper, and copper, and so on, until the whole is finished. The sides of the pile may be supported with rods of glass, or varnished wood fixed in the board on which it is built. Having wet both hands, touch the lower part of the pile with one hand, and the upper part with the other, constant little shocks of electricity will be felt until one hand be removed. If the hand be brought back, a similar repetition of shocks will be experienced. Hold a silver spoon in one hand, and touch with it the battery in the lower part, then touch the upper part with the tongue; the bitter taste is extreme. If the end of the spoon be put under the eyebrow, close to the ball of the eye, a sensation will be felt like the burning of red hot iron, but which ceases the instant the spoon is removed. The plates will soon become oxydated, and require cleaning in order to make them act.

## CHAPTER XI.

*Light—Bodies reflecting light—Colours changed by the application of the laws of chemical affinity—Experiments.*

Light is derived from the sun in the solar system. This is called solar or celestial light. It is also derived from terrestrial objects; as from combustion, friction, chemical attraction, &c. which is called terrestrial. It is generally accompanied with caloric. Every ray of common light contains in itself seven different kinds; these may be best separated by a triangular glass prism, but the same operation may be performed with a tumbler of water. The seven kinds of light differ in two remarkable characteristics; they are of different

colours, and degrees of refrangibility; viz. red, orange, yellow, green, blue, indigo and violet. The red is least refrangible; the violet most; and the intermediates vary in their degree of refrangibility according to this order of succession. The different colouring of bodies depends on the different kinds of light which they reflect to the eye. White bodies reflects all kinds of light; black, reflect none: the different kinds, according to the arrangement of the constituent atoms of bodies reflecting them, not according to the nature of those bodies.

Example 1. Prepare the following solutions: 1. Sugar of lead dissolved, 1 to 50 of water per weight. 2. Pearlash, 1 to 4 of water. 3. Corrosive sublimate, 1 to 30 water. 4. Copperas, 1 to 6 of water. 5. Sulphuric acid, 1 to 12 of water. 6. 1 to 100 of water. 7. Strong liquid of ammonia. 8. Tincture of red cabbage. 9. Tincture of galls. 10. Prusiate of potash. 11. Nitrate of mercury, made of 1 of mercury to 4 of nitric acid, to which add twice as much water. By mixing these liquids we make red—1 of 5 with 1 of 8. Orange, 4 of 3 with 1 of 2; limpid with 1 of 5. Yellow, 4 of 11 with 1 of 2. Green, 3 of 8 with 1 of 2; ruby red, with 1 of 5. Blue, 3 of 6 with 1 of 7; limpid with 1 of 5. Indigo, 1 of 4 with 1 of 10. Violet, add the red to the indigo. White, mix 3 of 1 with 1 of 1. Black, 3 of 9 with 1 of 4; limpid with 1 of 5.

These liquids either reflect different colours before they are mixed, from those which they reflect afterwards, or reflect no colour as some of them are limpid. It follows as a necessary conclusion, that colouring is not inherent in matter, but depends on the peculiar arrangement of the constituent atoms. As colours are changed by the various applications of the laws of chemical affinity, dyers, limners, &c. ought to be well acquainted with them.

Example 2. Rub two pieces of white quartz slightly together in the dark, and they will become luminous.

There are other bodies which absorb and give off light, as rotten wood, putrid fish, some artificial preparations, &c. Snow absorbs light by day, which it gives off at night—thus light is radiated from many substances, which seem not to belong to the class of luminous bodies. The particles of light are so extremely minute, that although they are projected in different directions, and cross each other, yet they are never known to interfere, or impede each other's course. It is still a disputed point, however, whether light be a substance com-



posed of particles like other bodies. In some respects it is obedient to the laws which govern bodies; in others it appears independent of them : thus, though its course is guided by the laws of motion, it does not seem to be influenced by the laws of gravity. It has never been discovered to have weight, though a variety of interesting experiments have been made in order to ascertain that point. Some have supposed that the rays of light, instead of being particles, consist of the undulations of an elastic medium, which fills all space, and which produces the sensation of light in the eye, just as the vibrations of the air produce the sensation of sound to the ear. Most of the phenomena may be accounted for by either hypothesis ; but that of their being particles applies more happily to some of the facts respecting the modifications of light by refraction and reflection. Twilight is occasioned partly by refraction, but chiefly by reflection of the sun's rays by the atmosphere, and it lasts till the sun is eighteen degrees below the horizon. Were no atmosphere to reflect and refract the sun's rays, only that part of the heavens would be luminous in which the sun is placed ; and if we could live without air, and should turn our backs to the sun, the whole heavens would appear as dark as in the night. In this case also, a sudden transition from the brightest sunshine to dark night, would immediately take place upon the setting of the sun.

## CHAPTER XII.

*Miscellaneous—Elective Affinity—Salt used in Bronzing—Peroxide of Tin used for various purposes—Important Mordant for Dying—To resemble the irregular discharge of Musketry—Powder—To detect the Carbonate of Lime—Clay unfit for Pottery—Alkaline Salts—To purify Meat—Sal Ammonia—Double elective Affinity.*

**Glauber Salts.** Put a tea spoonful of table salt into a wine glass, which has been previously dried on a plate ; pour upon it a tea spoonful of sulphuric acid. Muriatic gas will escape into the atmosphere, and glauber salts will be formed in the wine glass. *By this experiment elective affinity is illustrated.*

Put some sulphuric acid into a tumbler, diluted with six times as much water ; drop in some carbonate of soda until effervescence ceases ; and the nauseous taste of glauber salts

will be recognized. By slow evaporation it may be crystallized.

*Silver Boiling Powder.* White argol, common salt, of each a sufficient quantity; a small quantity of this powder is put into water, and plate is boiled in it, to which it gives a brilliant brightness.

*Borax.* Common borax dissolved in about sixteen times its bulk of hot water in a gallipot; then pour into it nearly half its weight of sulphuric acid; stir it on hot coals five or six minutes, then set it by to cool. Decomposition takes place; sulphate of soda is formed, which remains in solution; the boracic acid is disengaged, and appears as shining solid scales; pour off the solution and rinse the scales several times in cold water; each time wait for them to separate from the water; when well washed, they are nearly tasteless. Now dissolve some of the scales in alcohol on an earthen plate; set the alcohol on fire with a lighted roll of paper; as it burns the sides off, the flame will be tinged with a beautiful green.

The salt which this acid forms in combustion with soda is much used in bronzing, under the name of borax. It brings brass to the liquid state, when thrown upon it at a temperature considerably lower than its fusing point.

*Epsom Salts.* Put sulphuric acid into a tumbler, diluted with about six times as much water: drop in carbonate of magnesia until effervescence ceases; thus epsom salts are formed in solution.

*Pure Silex Powder.* Heat a gun flint red hot and throw it into cold water in order to render it brittle; pulverize it very fine and mix the powder with about five times its bulk of pearlash, melt the mixture, and keep it in a state of fusion fifteen minutes: now dissolve it in two or three times its bulk of water; pour in diluted sulphuric acid, a little at a time, as long as it continues to cause a precipitation. After it stands a little while to settle, pour off the liquid part, and wash or rinse the precipitate in hot water several times, until the water poured off is tasteless.

This substance is the principal ingredient in gun flints, rock crystals, cornelian, &c. On this principle glass is manufactured.

*Oxydated Tin.* Put some tin in an iron ladle and heat it no higher than to melt it; the surface will immediately absorb oxygen from the atmosphere, sufficient to form the *protoxid of tin*, called the yellow oxide. This may be scraped

off with an iron poker, when another similar pellicle will be formed; and the succession may be continued until the whole mass is an oxide.

If the protoxid of tin be put into a crucible, heated to redness, and continually stirred with an iron rod for some time, it will absorb another definite proportion of oxygen. It then becomes *peroxid of tin*, called the white oxide, or putty of tin.

The white oxide of tin is an excellent material for sharpening edge tools, as knives, razors, &c.—for polishing burnishers, glass lenses, &c. When melted with glass it forms the white enamel used for clock and watch faces, &c.

*Acetate of Alumine.* Dissolve equal parts of alum and sugar of lead in water, in separate wine glasses, and mix these solutions. The acids exchange bases; and the sulphate of lead falls down while the acetate of alumine remains over it in a liquid state. This liquid may be poured off for use.

It is an important mordant much used in dying, and it is manufactured in this way by calico printers.

*Explosive Powder.* Scatter some thin shavings of phosphorus over the bottom of a broad iron mortar; sprinkle crystals of oxymuriate of potash among them. Now, putting a leather glove upon the hand, rub the iron pestle smartly around among the shavings and the phosphorus, and a succession of explosions will be made, resembling the irregular discharge of musketry.

All explosive powders are indebted for their powers to the same principle. Gun powder is composed of 75 per cent. of nitrate of potash, 15 per cent. of charcoal, and 10 per cent. of sulphur.

*Lime.* Put a little potter's clay paste into a crucible, and heat it in the forge as high as white heat of iron: now pour it out upon a brick on a table, and it will be perceived that it is not melted; mix some of the same kind of clay intimately with about an equal quantity of pulverized marble or chalk, and heat it again as hot as before; pour it out and the whole mass will spread on the brick in the state of melted cinder.

On this principle potters reject all clay which contains lime. When clay contains a very small per centum of carbonate of lime, it would be sufficient to cause a kiln of potter's ware to melt. The carbonate of lime can always be detected by pouring a few drops of diluted muriatic acid. Ever so small a quantity of lime will cause an effervescence and prove the mass to be clay-marl, unfit for pottery.

*Alkaline Salts.* Dissolve in separate wine glasses a little copperas, blue vitriol, white vitriol and sugar of lead ; pour into each a small quantity of the solutions of either potash, soda, or ammonia, and the metallic oxide of the salt will be precipitated, and an alkaline salt formed in each glass.

This principle is of much use in the manufacture of articles used in medicine and the arts, as will be evident by attending the daily business of the laboratory.

*Liver of Sulphur.* Take some dry pearlash, and half as much sulphur, mix them and rub them well together : melt them in a crucible, covered with another. As soon as melted it must be poured out, and corked up tight in a phial to prevent its deliquescing. Sulphuretted hydrogen gas may be made with this equally as well as the sulphate of iron.

*Magnesia*, is found pure, or merely combined with water : sometimes it forms one of the constituents of the soap stone or talcose rocks, of asbestos, and some other minerals. It is generally obtained from sea water, after it is separated from the common salt : it exists in the state of a muriate and sulphate in sea water, from which it is obtained by mixing with it a solution of common pearlash. A double decomposition takes place ; and while the sulphate of potash remains in solution, the carbonate of magnesia falls down. This is the carbonated, or white magnesia of the shops.

*Calcined Magnesia.* Drop diluted sulphuric acid upon carbonate of magnesia of the shops, and it will effervesce violently ; that is, a bubbling will be caused by the escape of carbonic acid in the state of gas : put a little of the same carbonate of magnesia into a crucible, and keep it about the white heat of iron fifteen minutes : now after it cools, drop on it diluted sulphuric acid, and it will scarcely effervesce because the carbonic acid is driven out. If a little of it be dissolved in water it will give the alkaline test with red cabbage, much stronger than before heating.

It is difficult to drive off all the carbonic acid by heat, so that no effervescence can be produced by the application of sulphuric acid.

*Tooth Powder.* Heat finely pulverized charcoal to redness in an iron skillet, and pouring it while hot into a bowl of clean water, is the best of all substances to preserve the teeth from decay, after it has commenced. If kept in a bottle, it will remain under water, defended from gases, and if shaken up and a tea spoonful taken occasionally in the mouth, and

the teeth rubbed with it, every thing impure will be absorbed.

Putrid meat will become purified by immersing it in a similar manner: putrid water is purified by pouring into it heated charcoal powder.

2. Rad. irid. flor. four ounces; oss. sepia, two ounces; crem. tart. one ounce; ol. caryoph. sixteen drops; lake 16 drops.

3. Catechu, one ounce; cort. peruv. flav., crem. tart. cassia, bol. armen., of each 4 drachms; sang. dracon. myrrh, of each two drachms.

4. Rose pink, 20 ounces; bol. armen. oss. sepia, crem. tart. of each 8 ounces; myrrh 4 ounces; rad. irid. flor. 2 ounces; ess. bergam. half a drachm.

5. Oss. sepia, four ounces; crem. tart. rad. irid. flor of each two ounces; alum, ustri, rose pink, of each one ounce.

6. Magnesia, rad. irid. flor., rose pink, creta ppæ, of each two ounces; natr. ppi. six drachms; ol. rhodii, two drops.

*Ginger Beer Powders.* White sugar, one drachm two scruples; ginger, five grains; natr. pp. twenty-six grains in each blue paper: acid of tartar, one scruple and a half in each white paper. These quantities are for half a pint of water.

*Spruce Beer Powders.* White sugar, 1 drachm 2 scruples; natr. pp. 26 grains; essence of spruce, 10 grains, in each blue paper: acid of tartar, half a drachm in each white paper; for half a pint of water.

*Soda Powders.* Carbonate of soda, half a drachm in each blue paper: acid of tartar, twenty-five grains, in each white paper; for half a pint of water—a very pleasant and cooling beverage in summer: sugar, if desirable, may be added to the paper containing the acid of tartar.

*Portable Lemonade.* Acid of tartar, one ounce; sugar, six ounces; essence of lemon, one drachm: rub together, divide into twenty-four papers, for a tumbler of water each.

*Copperas, Sulphate of Iron.* Put diluted sulphuric acid into a Florence flask, consisting of about five times as much water as acid. Apply a very little heat, so as rather to warm than heat the acid. Drop in iron filings until they will fall to the bottom quietly; pour off the limpid liquid into earthen plates. This is copperas in solution; and by a slow evaporation it may be crystallized. On this principle the copperas of commerce is manufactured; but the process is different,

Iron pyrites is moistened and exposed to the atmosphere a considerable time in a shallow vat or box ; after it becomes covered with a crust it is dissolved in water or leached, and evaporated.

*Blue Vitriol.* Boil copper filings in sulphuric acid, and the salt will be formed in the liquid state : this may be evaporated in the usual way.

On this principle the blue vitriol of the shops is made, though the operation is not similar ; the native sulphuret is heated and exposed to air and moisture, and thereby the peroxide is obtained ; then the salt is readily formed by pouring sulphuric acid upon it.

*Oxymuriate of Potash.* Mix common salt three pounds, manganese two pounds, and add oil of vitrol two pounds, previously diluted with a sufficient quantity of water, distil into a receiver containing prepared kali, six ounces : dissolved in water, three pounds : when the distillation is finished, evaporate the liquid in the receiver slowly in the dark ; the oxymuriate will crystallize first in flakes ; stimulant, from one to two grains ; explodes when struck, or dropped into acid.

*Salt of Sorrel.* From the leaves of wood sorrel bruised and expressed ; the juice is then left to settle, poured off clear, and crystallized by slow evaporation ; one hundred weight of wood sorrel yields five or six ounces.

2. By dropping aqua kali into a saturated solution of oxalic acid in water, it will precipitate, and may be separated by filtration, if too much alkali is added, it is taken up, and will require an addition of the acid to throw it down again ; cooling—used to make lemonade, and whey, as also salt of lemons.

*Ammonia.* Ammonia is serviceable in dying, and in staining ivory ; but its principal use is in making the muriate of ammonia, of which it is the bases. It is formed by combining ammonia with muriatic acid. It is known in commerce by the name of *Sal Ammoniac*.

Convey some muriatic acid gas into a glass jar containing a portion of ammoniacal gas. From the mixture of these two invisible gases a solid substance will be produced ; viz. the common sal ammoniac.

Sal ammoniac is used by some dyers in what they call composition, to prevent the tin from precipitating. In tinning metals it is of use to cleanse the surfaces, and to prevent them

from oxydizing by the heat which is given to them in the operation. It is also employed in the assay of metals, to discover the presence of iron. Ammoniacal gas may be procured by heating strong liquid ammonia; this gas will be disengaged in abundance. On account of its affinity for water, it must be received over mercury, when it is intended to exhibit it in the state of gas. Pour a little caustic ammonia into a clear solution of sulphate of zinc. This will precipitate the metal in a white powder. If the phial be now shaken, the zinc will be immediately re-dissolved, thus serving as a test to distinguish zinc from iron and various metals. Drop as much nitrate of copper into water as will form a colourless solution; then add a little ammonia, equally colourless, and an intense blue color will arise from the mixture. Take the blue solution formed by the last experiment, add a little sulphuric acid, and the color will *disappear*; pour in a little solution of caustic ammonia; and the blue colour will be restored. Thus may the liquor be alternately changed at pleasure. Dissolve some oxide of cobalt in caustic ammonia; this will produce a *red* solution, different in color from that of all other metallic solutions.

1. *Double elective affinity.* Take about four parts of muriate of lime, and five parts of sulphate of soda, weighing them after being well dried over coals, on plates. Dissolve them in water separately. Now mix them in a wine-glass, and a precipitate of lime (gypsum) will soon settle at the bottom, and a solution of the muriate of soda will stand over it. On testing the new compounds with red cabbage, they will be found to be neutral salts, exhibiting neither the acid or alkaline test. On tasting the liquid, it will be found a solution of table salt.

Corrosive sublimate of the shops is made upon this principle, by sulphate of mercury, and muriate of soda.

Dr. Wallaston constructed a scale, by which the artist or chemist can at sight determine what proportions of any compounds are required for decomposing each other without loss. For example, if a given quantity of sulphuric acid and muriatic acid would require three times as much potash as alumine for saturation: though all these acids would differ from each other in the absolute quantity required.

2. Put into two wine-glasses, half a spoonful of muriatic

acid to each; weigh two equal parcels of carbonate of soda, about a teaspoonful to each glass. Drop the carbonate of soda from each parcel into its respective glass, till effervescence ceases. Now weigh what remains of each parcel, and they will be found equal. Try the two liquids with tasting rods, (pine sticks are as good for the purpose as tasting rods,) and the taste of common table salt will be recognized. From this experiment will be learned that the law of definite proportions, is of great importance in the arts. It regulates the uniformity of compound bodies, and prevents the evils which might arise from carelessness or mistake in the manufacture of many articles. For example, in the manufacture of copperas, 36 parts of protoxyde of iron will unite with precisely 40 parts of sulphuric acid. And in the manufacture of white vitriol, 42 parts of oxide of zinc will unite with 40 parts of sulphuric acid. These are the uniform proportions in the dry state, and each take 63 parts of water for crystallization.

3. Mix alcohol and water, or sulphuric acid and water. The qualities and sensible proportions of both these liquids will remain unchanged, being diffused among the water, there will be less of them in a given measure, but they will remain unchanged. Thus, by affinity, some substances unite in indefinite proportions, and their properties and sensible qualities are not changed.

### CHAPTER XIII.

#### *Simple Affinity—Soaps—Pomades.*

*To make Soap.* Melt a little common potash in an iron ladle, then put into it small bits of fresh meat and woollen rags, and boil them in a short time. The rags and meat will be dissolved and soap formed. On this principle soap is made by boiling any animal substance with lye. It requires very strong lye, or rather potash, to convert rags and some other animal substances into soap.

*White Soap.* Into half a wineglass of water, pour a teaspoonful of olive oil—no combination takes place—drop in a piece of pearlash of the size of half a pigeon's egg: let it dissolve and stir the mixture, which effects a chemical combination, and produces white soap.

This experiment illustrates simple affinity.

*Hard Soap.* Heat in a clean tin basin, good soft soap,



until dissolved, with about twice its measure of rain or river water—then put in about half a gill of fine common salt, to a quart of this solution. The muriatic acid of the salt will unite with the potash of the soap, and leave the soda of the salt to unite with the oil of the soap; this latter compound, after a little boiling, will become somewhat dense and float on the surface of the liquid. On draining off the liquid, which is chiefly muriate of potash, and drying the floating compound we obtain common hard soap.

Soap boilers make common hard soap on this principle. The liquid muriate of potash, they call waste lye, or dead lye. The fine hard soap is made directly from the barilla or kelp, which is a rough sub-carbonate of soda, made from the leached ashes of sea-weeds.

**White Wash Balls.** One pound sap. alb. hisp.; 3 pts. aqua rosar. album. ovor no. ij.; one ounce aq. kali ppi.: boil till hard again, add one scruple ol. lign., rhod., ten drops ol. caryoph. one drachm ess. jasmin. half a drachm of ess. neroli, and form into squares.

2. Five pounds of white soap, four ounces rad. irid. flor.; three ounce. amyli; one ounce, styræ calum. aq. rosar. q. s.

3. One pound sap. alb. hisp. almonds blanched, beat up into a paste with rose water and orange flower water, three ounces; one ounce magister. marcasitæ; two drachms of kali ppi.; six grains of musk; three grains of cive; one scruple ol. lign. rhodi; one drachm ess. jasmin.

**Cream Balls.** Seven pounds white curd soap; one pound amyli; water a sufficient quantity; beat it together, weigh it into ounce balls, and roll in pulverized amyli.

White soap, starch, of each one pound; ess. lemon four drachms; aq. rosar. eight ounces; make into balls of three ounces and a half each.

**Red Mottled Wash Balls.** Cut white soap into small square pieces, roll them in vermilion, and squeeze the pieces together into balls without mixing them more than is necessary.

**Blue Mottled Wash Balls.** In like manner rolling the pieces in powder blue.

**Windsor Soap.** Hard curd soap, melted and scented with ol. carui and ess. bergam.; an inferior sort is made with ol. carui only.

**Starkey's Soap.** Made by rubbing warm kali ppi. with ol. turpentine, adding a little water.

*Macquier's Acid Soap.* Four ounces sapon. ven.; ol. vitriol, q. s. add the acid by degrees to the soap, rendered soft by a little water, continually rubbing the mass in a mortar—detergent, used when alkalies would be prejudicial.

*Shaving Liquid—Shaving Oil.* Sap. Moll: four pounds; spirits of wine rectified five pints.

*Essence Royale pour fair la barbe.* Sap. cast. eight oz., proof spirits one pint.

*Pomade de la jeunesse.* Pomatum mixed with pearl white; or magestery of bismuth, turns the hair black.

*Pomade Divine.* One pound eight ounces of beef's marrow; cinnamon, one ounce and a half; stor. calam. benzoini, rad. irid flor. of each once ounce; caryoph. nuc. myrist. of each one drachm.

2. Sevi. ovilli; one pound eight ounces; stor. calam, benzoini, rad. irid. flor., rad cyperi, cinnam, caryoph. arom: nuc. mosch., of each nine drachms; keep melted in a gentle heat for some time, then strain.

3. Sevi. ovilli four pounds; cera alb. one pound; ess. bergam. ess. lemon, of each one ounce and a half; ol. lavender., ol. origani, of each four drachms.

#### CHAPTER XIV.

*The influence of Premiums in Scotland and Ireland—Balance of Trade in favour of Great Britain—Middle and Eastern States.*

IT is well understood that artificers, or artisans, or mechanics, are those who carry on any mechanical trade; that they are very numerous in all great trading countries; still, perhaps, their importance in society is not generally considered by those, who move (in what is said to be) a more exalted sphere of life; or more likely, by those *who flatter themselves* that they have been cast in finer moulds. It is not expected, that this essay will be very pleasing to the taste of *those gentlemen*, who measure their consequence either by their cash or garb; but we hope it will contribute in some measure to produce a better feeling towards so important a class of community, the mechanics, and lead all to examine, if they are not alloyed with more human vanity than ordinarily becomes them. As things are constituted at present among the trading countries of the world, those which subsist upon their natural productions, or merely by bartering or exchanging such

commodities, for those of other countries, have never distinguished themselves as a trading people. The Indians in North America, as well as the Negroes in Africa, are plain instances of the fact. If the Chinese were deprived of their useful artificers, (or, if you please, manufacturers, for, they may as reasonably be called the one as the other, though custom among us has made a distinction,) they would very probably degenerate into the like savage dispositions with the wildest Africans, or American Indians. And this we presume, also, might be the case with the people of the United States. It is the arts which keep the mass of people in useful action, and which keep their minds also on useful invention, beneficial to the whole community; consequently, this is the grand preservative against that barbarism, brutality and a slothfulness in trade, which ever attend an indolent and inactive stupidity. The due cultivation of practical manual arts in a nation, has a greater tendency to polish, and humanize mankind, than mere speculative science, however refined and sublime it may be; and these arts are not only the most naturally adapted to the bulk of the people, but by giving real existence to their ideas, by their practical inventions, improve their minds more sensibly and feelingly, than any ideal contemplation could do, which may have no other being, but in the mind of the speculator. Moreover, it is observable, that those who are fruitful in useful inventions and discoveries, in the practical mechanical arts, are men, not only of the greatest utility, but possess an understanding, which should be most highly estimated. Whether this may be attributed to the constant exercise of their intellectual faculties in those things which they *see* and *feel*, may deserve the consideration of those who contemplate on the most natural way of improving the mind:

The delicate mechanism of a watch, by those great artists, a Graham, or an Ellicot, demonstrate the utility of such artisans to a trading country, as their workmanship has been admired throughout the civilized world. It is the same by other artificers who excel in their peculiar branch. This not only brings credit and honour, but treasures into a nation, in proportion as they are stocked with such celebrated mechanics or artificers. An English writer says, "nothing is more obvious than that the commerce and navigation of the nation, principally depends on the daily improvement made by our

artificers, in the infinite and amazing variety in our mechanic and manufactural arts ; wherefore, artists, who strike out new inventions, or who improve the old mechanics and manufactures, are deserving of some regard and encouragement, more than they acquire to themselves, by dint of their own peculiar profession only." Experience has manifested the extraordinary effect of those small rewards given in Scotland and Ireland, for the improvement of their manufactures ; though it is not always the case, that premiums operate so powerfully, as the motive of emulation ; for that credit and reputation, which attends a man's excelling in his employment, has, sometimes, a far greater influence upon the industrious and ingenious mind, than pecuniary rewards only. Yet these are not to be neglected in trading countries ; as it is most commonly the case, that new inventions or improvements, made by one for the benefit of trade, are soon enjoyed equally by all ; the inventors, very rarely, being able to preserve the benefit to themselves, scarcely long enough, to recompense for the time and expense they have generally been obliged to bestow upon them.

If it was fashionable for persons of leisure to devote a proportion of their rural retirements to practical or experimental philosophy, it might not only prove a salubrious bodily exercise to them, but a great benefit and advantage to our artificers in general, and consequently to the general trade and traffic of the country.

The mechanic inventions are improved by others, besides the common artificers themselves. This will undeniable appear, if we will be convinced by instances ; for it is evident, that various manufactures have been given us by men, who were not bred up in trades that resembled those which they discovered. The admirable art of composing letters, so far from being started by a man of learning, was the device of a soldier ; and powder, to make recompense, was invented by a monk, whose course of life was most averse from handling the materials of war. The ancient Tyrian purple was brought to light by a fisher ; and if ever it can be recovered, it is likely to be done by some such accident. The scarlet of the moderns is a very beautiful colour, and it was the production of a chemist and not of a dyer. The warmth and vigour which attend new discoveries, is seldom confined to its own sphere ; but is generally extended to the ornament of its

neighbour. The ordinary method in which this happens, is the introduction of new arts. It is true, indeed, the increase of tradesmen is an injury to others that are bred up in particular trades, if they are enabled to supply all demands in their various branches; but there can never be too great a surplus of trades. That country is still the richest, and most powerful, which produces and employs the greatest number of artificers and manufacturers.

The hands of men employed, are true riches; the saving of those hands by invention of arts, and applying them to other works; will increase those riches. Where this is done, there will never a sufficient subject for profit be wanting; for, if there is not vent for the productions at home, a market will be opened abroad. Thus, in those districts where commerce and manufactures do not flourish to any degree, exchange is against them, and in favour of those places, where they are more extended; hence we learn the balance of trade is against us, and in favour of Great Britain; but we need not cross the Atlantic to maintain our position, for the argument is applicable to the western and southern in favour of the middle and New-England states; to those who negotiate in bills of exchange, this subject cannot be new. Where the ways of life are few, the fountains of profit will be possessed by few; whence it is manifest that poverty among a people is caused by a small number, not by having a multitude engaged in a variety of trades. An English writer asserts, that, "by the increase of artificers and manufacturers, all things will be dearer, because more must be maintained; for the high rate of things is an argument of the flourishing, and the cheapness, of the scarcity of money, and ill-peopling of all countries. The first is a sign of many inhabitants, which is true greatness, the second is only a fit subject for poets to describe, and to compare to their golden age; for, where all things are without price or value, they will be without arts, or empire, or strength." From the sentiments of this zealous promoter of the useful arts, for the benefit of commerce, it is evident that he makes the prosperity of a trading nation to consist in the multiplying of the number of new trades; that is to say, in multiplying the different species of mechanics, artificers and manufacturers; it is for want of this, that all the old ways of gain become overstocked, and then people complain for want of trade, when the true cause is owing to the want of

art, or to the want of the invention of a number of new trades, and new arts, in proportion to the increase of population, and in proportion as other rival states strike into the like trades and arts, with similar advantages. Finally, if our labourers are as diligent as our lawgivers, we shall prove the most labourious, if not the most wealthy nation under heaven. But the true method of increasing industry, and improvement, and wealth, and respectability, is that which was recommended by the Royal Society of London, “by *works and endeavours*, and not by the prescriptions of *words, or paper commands*.”

## CHAPTER XV.

*Mineralogy—characters of Minerals—classification of Minerals—Salt Springs—Platina—Gold—Silver—Mercury—Copper—Lead—Iron—Tin—Zinc—Manganese—Antimony—Arsenic.*

### MINERALOGY.

THE whole science of mineralogy has been created since the year 1770. All the solid materials of which this globe of ours is composed have received the name of minerals. But it is only very lately that the method of ascertaining the component parts of these substances was discovered, or that it was possible to describe them so as to be intelligible to others. Nothing at first appears easier to describe than a mineral, but in reality it is attended with a great deal of difficulty. The properties of minerals must be described in terms rigidly accurate, which convey precise ideas of the very properties intended, and of no other. The smallest deviation would lead to confusion and uncertainty. Mineralogy therefore must have a language of its own, that is to say, it must have a term to denote every mineralogical property, and each of these terms must be accurately defined. The language of mineralogy was invented by the celebrated Werner, of Fryburg, and first made known to the world by the publication of his treatise on the *External Characters of Minerals*. The object of this philosopher was to invent a method of describing minerals with such precision, that every species could readily be recognized by those who were unacquainted with the terms employed. For this purpose, it was necessary to make use of those properties only, which presented themselves to our senses on inspecting the mineral. These were

called by Werner, external characters, because they may be ascertained without destroying the mineral examined. These constitute the first division of the characters of minerals. To the second belong those which are derived from a chemical composition, or discovered by any chemical change which the mineral suffers; to the third, are referred those properties which are afforded by certain physical characters, derived from circumstances frequently observed with regard to a mineral, as to the place where it is found, or the minerals by which it is usually accompanied.

Werner divides the external characters of minerals into two kinds, viz. *general and particular*. The general characters are the following: 1. Colour. 2. Cohesion. 3. Unctuousity. 4. Coldness. 5. Weight. 6. Smell. 7. Taste.—The particular characters are: 1. Aspect of surface. 2. Aspect of the fracture. 3. Aspect of the distinct concretions. 4. General aspect. 5. Hardness. 6. Tenacity. 7. Frangibility. 8. Flexibility. 9. Adhesion to the tongue. 10. sound.

*General Characters.* 1. The *colours* of minerals are extremely various. Werner conceives eight fundamental colours, and describes all the rest as compounds of various proportions of these. The fundamental colours are, 1. Snow white. 2. Ash Grey. 3. Velvet black. 4. Berlin or Prussian blue. 5. Emerald green. 6. Lemon yellow. 7. Carmine red. 8. Chesnut brown. II. With respect to *cohesion*, minerals are either, *solid, friable, or fluid*. III. With respect to *unctuosity*, minerals are distinguished into *greasy and meagre*; the first have a certain degree of greasiness in feeling; the second not. The other four general characters require no particular description.

*Particular Characters.* I. In the aspect of the surface of the mineral, three things claim attention. 1. The *shape* of the mineral. 2. The kind of *surface*. 3. The *lustre* of the surface, which is either splendent, shining, glistening, glimmering, or dull. II. When a mineral is broken, the new surface exposed is called the fracture. Three things claim attention: 1. The lustre of the fracture. 2. The kind of fracture. 3. The shape of the fragments. III. *Distinct concretions* are distinct masses, which may be separated from each other, without breaking through the solid part of the mineral, by natural seams. Three particulars in respect to

them are, 1. Their *shape*. 2. Their *surface*. 3. Their *lustre*. IV. Under the head of *general aspect*, three particulars are comprehended. 1. The *transparency*. 2. The *streak*. 3. The *soiling*, or *stain* left when rubbed. V. Minerals are either, 1. *Hard*. 2. *Semi-hard*, or 3. *Soft*. VI. With respect to *tenacity*, minerals are, 1. *Brittle*, when on being cut with a knife the particles fly away with a noise. 2. *Sectile*, when the particles do not fly off but remain. 3. *Ductile*, when the mineral can be cut into slices. VII. By *frangibility* is meant the resistance which minerals make when we attempt to break them. The degrees are five, 1. *Very tough*. 2. *Tough*. 3. *Moderately tough*. 4. *Fragile*. 5. *Very fragile*. VIII. With respect to *flexibility*, some are, 1. *Elastic*. Others, 2. *Common*. Others, 3. *Inflexible*. IX. Some minerals *adhere* to the tongue, 1. *Very strongly*. 2. Others, *moderately*. 3. Others, *slightly*. 4. And others, *very slightly*. X. Some minerals give a ringing sound, others a grating sound, and others a creaking sound, as tin. With respect to *electricity*, some minerals become electric when heated, others when rubbed, others cannot be rendered electric. The electricity of some is *positive*, of others *negative*.

### CLASSIFICATION OF MINERALS.

Minerals are usually arranged under four classes; earthy, saline, inflammable and metallic. The *earthy* contain all such as derive their qualities from the earths; and they are divided into genera, according to the particular earth, which predominates in each, or more properly into families, according to their resemblance, in external characters, as the diamond family, the ruby family, tale family, and others. The diamond, of which there is only a single species, is the hardest and most beautiful of all the mineral productions. When heated to the temperature of melting copper, and exposed to a current of air, it is gradually but completely combustible. It is wholly converted into carbonic acid, and therefore consists of pure carbon. By means of diamond power, this substance can be cut and polished on a wheel, in the same way as other gems are wrought by emery. It is manufactured by jewellers into brilliants and rose diamonds; employed by glaziers for cutting glass, by lapidaries for cutting and engraving on the hardest gems, and in the finer kinds of clock work



The ruby family is composed of seven species. They are all extremely hard, and several of them highly valued on account of their beauty. The saline minerals comprehend all the combinations of alkalis with acids, which exist in the mineral kingdom; such as salt petre or nitrate of potash, common rock salt, or muriate of soda, and sal ammoniac, or the muriate of ammonia.

The salt springs in some parts of the United States, owe their origin to beds of fossil salt. The rain water which penetrates to their surface, effects the solution of a certain portion of them, with which it comes in contact, and thus becomes in some cases, it is said, ten times saltier than the water of the sea. The *inflammable* minerals, comprehend all combustible bodies, except metals and the diamond, and include sulphur, resins, bitumens, and graphite. Among the bitumen are found the several varieties of mineral coal, that are used for fuel, gas lights, &c.

The *metallic* minerals comprehend all the mineral bodies that are composed either entirely of metals, or of which metals constitute the most considerable and important part. It is from the minerals of this class that all metals are extracted. The ores are found in a native state, either simple, consisting of only one substance, or compound, when composed of two or more substances. Of the metals, the first is *platina*, which is the heaviest. Platina is found among the gold ores of South America, in the form of small grains or scales. Its colour is between steel grey and silver white, and its ductility and malleability is very great. Gold is never found in a mineralized state, but it occurs native in many parts of the world generally alloyed with a little silver or copper, and commonly in the form of grains. It is the heaviest metal of all metals except platina, and although its tenacity is such that a wire of one tenth of an inch in diameter, will support a weight of five hundred pounds without breaking, yet it possesses less tenacity than iron, copper, platina or silver. It is ductile and malleable beyond any known limits. The gold beaters extend it by hammering a number of thin rolled plates between skins or animal membranes, upon blocks of marble fixed in wooden frames. A grain of gold has been extended to more than forty two square inches of leaf, and an ounce, which in the form of a cube, is not half an inch either high, broad, or long, is beaten under the hammer into a sur-

face of 146 1-2 square feet. There are gold leaves, not thicker in some parts, than the three hundred and sixty thousandth part of an inch; but on wire used by lace makers it is still thinner. An ingot of silver, usually about thirty pounds weight, is rounded into an inch and a half in diameter, and 22 inches long. Two ounces of gold leaf are sufficient to cover this cylinder, and frequently effected with a little more than one. The ingot is repeated drawn through the holes of several irons, each smaller than the other, till it becomes finer than a hair; and yet the gold covers it, and does not leave the minutest part of the silver bare, even to the microscope. It has been calculated that it would take 14 millions of filings of gold, such as are on some gilt wire, to make up the thickness of one inch. The ductility of it is such, that one ounce is sufficient to gild a silver wire more than thirteen hundred miles long.

Gold may be dissolved in nitro-muriatic acid and it thus becomes muriate of gold, which is obtained in small crystals, and is very soluble in water. If white satin ribbon, or silk, be moistened with a diluted solution of gold, and, while moist exposed to hydrogen, or sulphuric acid gas, the metal will be immediately reduced and the silk become gilt with a regular coat of gold. The potters dissolve gold to be applied to the common porcelain; and it is used in a state of solution for staining ivory and ornamental feathers. It gives a beautiful purple red; even marble may be stained with it.

*Silver*, is the most brilliant of metals. You may know when silver is pure, by heating it in a common fire, or in the flame of a candle; if it is alloyed it will become tarnished; but if it be pure silver, it will remain perfectly white. It is exceedingly ductile, of great malleability and tenacity.

Of the salts of silver, the nitrate is best known, and when melted and run into moulds, it forms the lunar caustic of the apothecary.

*Mercury*, in the temperature of our atmosphere, is a white fluid metal, having the appearance of melted silver. When submitted to a sufficient degree of cold it is similar in appearance to other metals, and may be beaten into plates; at the poles it would probably be always solid.

The quicksilver mine of Guanea Velica, in Peru, is 170 fathoms in circumference, and 480 deep. In this profound abyss are seen streets, squares and a chapel: thousands of

flambeaux are continually burning to enlighten it. Those who work in the mine are generally afflicted with convulsions. Notwithstanding this the unfortunate victims of insatiable avarice are crowded together, and plunged naked into these abysses. Tyranny has invented this refinement in cruelty, to render it impossible for any thing to escape its restless vigilance.

*Copper*, is the most ductile of all the metals except gold. The salts of copper are numerous and much used in the arts connected with chemistry. All the salts are poisonous; therefore, great care should be taken not to taste wantonly the solutions.

*Lead*, is malleable and ductile, but possesses very little tenacity. It may be mixed with gold and silver in a moderate heat; but when the heat is much increased, the lead rises to the surface, combined with all heterogeneous matters. The ore of lead is so poisonous, that the steam arising from the furnaces where it is worked, infects the grass, in all the neighboring places, and kills the animals which feed on it. Culinary vessels, lined with a mixture of tin and lead, which is the usual tinning, are apt to communicate to acid food, pernicious qualities, and require to be used with great caution. The same may be said of liquors, and other acid substances kept in glazed ware, and of wines adulterated with litharge, and such other preparations of lead as are sometimes used, for the purpose of rendering them sweet.

*Iron*. If utility were made the standard of estimation, iron would hold the first place in the class of metals, and would be counted more valuable than gold, as it appears indispensably necessary to the carrying on of every manufacture. There has never been an instance of a nation, acquainted with the art of manufacturing iron, which did not in time attain to a degree of civilization, greatly beyond the inhabitants of those countries where this metal was wanting, or its use unknown. It is plentifully and universally diffused throughout nature, pervading almost every thing, and is the chief cause of colour in earths and stones. It may be detected in plants and animal fluids.

*Tin*, must have been known very early, as it is mentioned by Homer, and also in the books of Moses. Tin enters into combination with many of the metals, and forms alloys with them, some of which are of great importance. It is not very

ductile, but so malleable, that it may be beaten into leaves thinner than paper. Tin foil, as it is usually termed, is about one thousandth part of an inch thick. It is employed to give brightness to several articles; used in forming reds and scarlets. Substances which produced to the ancients only faint and fleeting colours, give us such as are brilliant and durable, by the use of a solution of this metal,

*Zinc*, is one of the most abundant metals in nature, except iron. It is used in China for the current coin, and for that purpose it is employed in its utmost purity. Until recently it was used in Wales for mending roads. When zinc is heated, it readily attracts oxygen; and at a white heat the absorption of oxygen is so rapid and violent, that the oxide immediately sublimes, and for this reason it has acquired the name of flowers of zinc. Combined with copper and tin, the mixtures constitute some of the most useful compound metals. It is used in medicine, is the base of white vitriol, and its carbonate or oxide may be advantageously substituted for white lead in painting.

*Manganese*, is a brilliant metal, of a darkish white colour, inclining to grey, of considerable hardness, and of difficult fusibility. When exposed to the air it absorbs oxygen with rapidity, and falls into powder. Its oxides are used in preparing the bleaching liquor, in purifying glass, and in glazing black earthen ware. By the application of a red heat the black oxide produces oxygen gas in great abundance.

*Antimony*, is a brilliant, brittle metal, of a silvery colour, which has not much tenacity, and entirely destitute of ductility. It is wholly volatilized by heat; is susceptible of vitrification. Its oxides are employed in medicine, and in colouring glass.

*Arsenic*, is generally found in combination with sulphur, oxygen and many of the metals. Its colour is bluish, or greenish white, becoming on exposure to the air, dark, almost black; it is extremely brittle, and the softest of all metals; and is one of the most active of mineral poisons. Beautiful shades of different colours may be given to different substances by solutions of arsenic; so that the substances which are most injurious to the animal economy, appear to be endowed with properties for embellishing the works of creation, and by imparting colour to other bodies, is made to minister in various ways to our gratification. How diversified are the means

which the Creator has adopted for the promotion of his benevolent designs !

## CHAPTER XVI.

*The art of assaying Ores—Fluxes—in the humid way—in the soft way—by cupellation—to assay plated metals—parting of gold and silver—by aqua fortis—by cementation—dry parting—to determine the quality of gold—to obtain silver pure from alloy—weight of metals—specific gravity of bodies.*

BEFORE metallic ores are worked in the large way, we should know what sort of metal, and what portion of it, is to be found in a determined quantity of the ore, in order to ascertain whether it will be profitable to extract largely, and in what manner the process is to be performed.

The assaying may be performed in the dry or moist way ; the first is the most ancient, and in many respects the most advantageous, and consequently continues to be mostly used. Assays are made either in crucibles with the blast of the bellows, or in tests, under a muffle. The assay weights are always imaginary. Sometimes an ounce represents an hundred weight on the large scale, and is subdivided in the same number of parts, as that hundred weight is in the great ; so that the contents of the ore obtained by the assay, shall accurately determine by such relative proportions, the quantity to be expected from any weight of the ore on a larger scale. In the lotting of the ore, care should be taken to have small portions, from different specimens, which should be pulverized and well mixed in an iron or brass mortar. The proper quantity of the ore is now taken, and if it contains either sulphur or arsenic, it is put into a crucible or test and exposed to a moderate degree of heat, till no vapour arises from it ; to assist this volatilization, some add a small quantity of powdered charcoal.

**FLUXES.** To assist the fusion of the ores, and to convert the extraneous matters connected with them into scoria, assayers use different kinds of fluxes. The most usual and efficacious materials for the composition are borax, tartar, nitre, sal ammoniac, common salt, glass, flour-spar, charcoal powder, pitch, lime, litharge, &c. in different proportions.

*Crude of White Flux.* This consists of one part of nitre and two of tartar, well mixed.

*Black Flux.* The above crude flux detonates by means of kindled charcoal; and if it be effected in a mortar slightly covered, the smoke that rises unites with the alkalized nitre and the tartar, and renders it black.

*Cornish Reducing Flux.* Ten ounces of tartar, three oz. and six drachms of nitre, three ounces and one drachm of borax; well mixed.

*Cornish Refining Flux.* Defflagrate, then pulverize, two parts of nitre, and one part of tartar.

In working at large, such expensive means cannot be applied to effect our purpose, as the inferior metals would be too much enhanced in value; consequently, where the object is the production of metals in the great way, in smelting works, cheaper additions are used; such as lime stone, felted-spar, flour-spar, quartz, sand, slate, and slugs, which are to be chosen according to the different views of the operator. The iron ores on account of the argillaceous earth they contain, require calcareous additions, and the copper ones, rather slugs, or vitrescent stones, than calcareous earth.

*Humid assay of Metallic Ores.* The mode of assaying ores for their particular metals by the dry way, is deficient, so far as relates to pointing out the different substances connected with them, because they are always destroyed by the process for obtaining the assay metal. The assay by the moist way is more correct, because the different substances can be accurately ascertained. The late celebrated Bergman first communicated this method. It depends upon a knowledge of the chemical affinities of different bodies for each other; and must be varied according to the nature of the ore—it is very extensive in its application, and requires great patience and address in its execution. To describe the treatment of each variety of metallic ores would take too much of our room; but to give a general idea, we shall describe the procedure, both in the dry and humid way, on one species of all the different ores.

*To assay Iron ores.* No. 1. The ore must be roasted till the vapour ceases to rise. Take two assay quintals of it, and triturate them with one of flour-spar; three-fourths of a quintal of powdered charcoal, and four quintals decrepitated sea-salt; this mixture is to be put into a crucible, and the crucible itself exposed to a violent fire for an hour, and when it is cool, broken. If the operation be well conducted, the

iron will be found at the bottom of the crucible, to which must be added those metallic particles, which may adhere to the scoria. The metallic particles so adhering may be separated by pulverizing it in a paper, and then attracting them with a magnet.

No. 2. If the ore should be in a calciform state, mixed with earths, the roasting of it previous to assaying, if not detrimental, is at least superfluous; if the earths should be of the argillaceous and silicious kind, to half a quintal of them, add of dry quicklime and flour-spar, of each one-fourth of a quintal, reduced to powder, and mix them with one-fourth of a quintal of powdered charcoal, covering the whole with one ounce of decrepitated common salt; and expose the luted crucible to a strong forge fire for an hour and a quarter, then let it gradually cool, and let the regulus be struck off and weighed. If the ore contain calcareous earth there will be no occasion to add quicklime; the preparations of the ingredients may be as follows: viz. one assay quintal of ore, one of decrepitated sea-salt, one half of powdered charcoal; and one of flour-spar, and the process conducted as above.

There is a great difference in the reguli of iron; when the cold regulus is struck with a hammer, and breaks, the iron is called cold short; when struck red hot, it is called red short, but if it resist the hammer, both in its cold and ignited state, it is good iron.

*Humid assay of Iron Ore.* To assay the calciform ores, which do not contain much earthy or stony matter, they must be reduced to a fine powder; dissolved in marine acid, and precipitated with the Prussian alkali. A determinate quantity of the alkali must be previously tried, to ascertain the portion of iron which it will precipitate, and the estimate made accordingly. If the iron contains a considerable portion of zinc or manganese, the precipitate must be calcined to redness, and the calx of the zinc; when this is separated, the calx should again be treated either with nitrous acid, with the addition of sugar, or with the acetous acid, which will dissolve the manganese, if any; the remaining calx of iron may then be dissolved by the marine acid, and precipitated by the mineral alkali, or it may be further calcined, and then weighed.

*Zinc Ores.* Take the assay weight of roasted ore, and mix it well with one-eighth part of charcoal dust, put it into a strong luted earthen retort, to which must be fitted a recei-

ver ; place the retort in a furnace and raise the fire, and continue it in a violent heat for two hours ; then cool gradually, and the zinc will be found hanging to the neck of the retort in its metallic form.

*In the humid way.* Distil vitriolic acid over calamine to dryness ; the residuum must be lixiviated in hot water ; what remains undissolved is silicious earths ; to the solution add caustic volatile alkali, which precipitates the iron and argil, but keeps the zinc in solution. The precipitate must be redissolved in vitriolic acid, and the iron and argil separated.

*Tin Ores.* Mix a quintal of tin ore, previously washed and pulverized, roast till no arsenical vapours arise, with half a quintal of calcined borax, and the same quantity of pitch, pulverized ; put the whole into a crucible moistened with charcoal dust and water, and the crucible placed in an air furnace. After the pitch is burnt, give a violent heat for a quarter of an hour ; and on withdrawing the crucible, the regulus will be found at the bottom.

If the ore be not well washed from earthy matters, a larger quantity of borax will be requisite, with some powdered glass ; and if the ore contains iron, some alkaline salts may be added.

*In the humid way.* Let the tin ore be well separated from its stony matrix, by well washing, and reduced to the most subtile powder ; digest in concentrated oil of vitriol, in a strong heat for several hours ; when cooled, add a small portion of concentrated marine acid, and let it stand one or two hours ; then add water ; and when the solution is clear, pour it off and precipitate it by fixed alkali.

One hundred grains of this precipitate, well washed and dried, are equivalent to one hundred of tin in its reguline state, if the precipitate consists of pure tin ; but if it contain copper or iron, it must be calcined in a red heat for an hour, and then digested in nitrous acid, which will take up the copper ; and afterwards in marine acid, which will separate the iron.

*Lead Ores.* As most of the leads ores contain either sulphur or arsenic, they should be well roasted. Take a quintal of roasted ore, and the same quantity of calcined borax ; half a quintal of fine powdered glass ; a quarter of a quintal of pitch, and as much clear iron filings. Line the crucible with wet charcoal dust, and put the mixture into the crucible ; place it before the bellows of a forge fire. When it is red hot, raise the fire for twenty minutes, withdraw the crucible ; when cold, break it.



*In the humid way.* Dissolve the ore by boiling it in diluted nitrous acid ; the sulphur, insoluble stony parts, and calx of iron will remain. The iron may be separated by digestion in caustic fixed alkali. The nitrous solution contains the lead and silver, which should be precipitated by the mineral fixed alkali, and the precipitate well washed in cold water, dried, and weighed. Digest it in caustic volatile alkali, which will take up the calx of silver ; the residuum being again dried and weighed, gives the proportion of the calx of lead, 132 grains of which, are equal to 100 of lead in its metallic state. The difference of weight before and after the application of the volatile alkali, gives the quantity of silver ; 129 grains of which are equal to 100 of silver in the metallic state.

*Copper Ores.* Take an exact ounce troy of the ore previously pulverized, and calcine it well; stir it all the time with an iron rod, without removing it from the crucible : after the calcination add an equal quantity of borax ; half the quantity of fusible glass, one-fourth the quantity of pitch, and a little charcoal dust ; rub the inner surface of the crucible with a paste composed of charcoal dust, a little fine powdered clay and water ; cover the mass with common salt, and put a lid on the crucible, which place in a furnace; raise the fire gradually, till it burns briskly, and the crucible kept in it for half an hour ; stir the metal often with an iron rod, and when the scoria adhering to the rod appears clear, take the crucible out and suffer it to cool, when it must be broken, and the regulus separated and weighed ; this is called black copper, to refine which, equal parts of common salt and nitre are to be well mixed together. The black copper is brought into fusion, and a teaspoonful of flux is thrown on it, which repeat three or four times ; then pour the metal into an ingot mould, and the button is found to be fine copper.

*In the humid way.* Make a solution of vitreous copper ore, in five times its weight of concentrated vitreous acid, and boil it to dryness ; add as much water as will dissolve the vitriol thus formed ; to this solution add a clean bar of iron, which will precipitate the whole of the copper in its metallic form. If the solution be contaminated with iron, the copper must be redissolved in the same manner, and precipitated again. The sulphur may be separated by filtration.

*Bismuth Ores.* If it be mineralized by sulphur, or sulphur and iron, a previous roasting will be necessary. The strong

ores require no roasting only to be reduced to fine powder. Take the assay weight and mix it with half the quantity of calcined borax, and the same of pounded glass ; line the crucible with charcoal ; melt it as quickly as possible ; when well done, take out the crucible, and let it cool gradually. The regulus will be found at the bottom.

*In the humid way.* Bismuth is easily soluble in nitrous acid, or aqua-regia. The solution is colourless, and is precipitable by the addition of pure water ; 118 grains of the precipitate from nitrous acid, well washed and dried, are equal to 100 of bismuth in its metallic form.

*Antimonial Ores.* Bore a number of small holes in the bottom of a small crucible, place it in another, a size larger, lute them well together ; then put the proper quantity of ore in small lumps in the upper crucible, lute thereon a cover ; place the vessels on a hearth ; surround them with stones six inches distant ; fill with ashes the intermediate space, that the under crucible may be covered with them ; but upon the upper, charcoal must be laid : the whole made red hot by the assistance of the hand bellows. The antimony runs thro' the holes of the upper vessel, being easy of fusion, into the other, where it is collected.

*Humid assay of arseniated antimony.* Dissolved the ore in aqua-regia, both the regulus and the arsenic remain in solution ; the sulphur is separated by filtration. If the solution be boiled with twice its weight of strong nitrous acid ; the regulus of antimony will be precipitated, and the arsenic converted into an acid, which may be obtained by evaporation to dryness.

*Manganese Ore.* To obtain the regulus, mix the calx or ore of manganese with pitch, made into a ball ; put it into a crucible, lined with powdered charcoal, one-tenth of an inch on the sides, and one-fourth at the bottom ; then fill the empty space with charcoal dust ; cover the crucible with another inverted and luted on, and expose it to the strongest heat of a forge for an hour or more.

*In the humid way.* Roast the ore well to dephlogistigate the calx of manganese and iron, if any, and then treat with nitrous acid to dissolve the earths. Treat the residuum with nitrous acid and sugar, when a colourless solution of manganese is procured, and also of the iron, if any. Precipitate with Prussian alkali, digest the precipitate in pure water ; the Prus-

siate of manganese will be dissolved, whilst the Prussiate of iron will remain undissolved.

**Arsenical Ores.** Made by sublimation in close vessels. Beat the ore into small pieces ; put them into a matrass, which place in a sand pot, with a proper degree of heat ; the arsenic sublimes, and adheres to the upper part of the vessel ; collect it carefully, and ascertain its weight. A single sublimation will not be sufficient ; sometimes, as in many cases, the arsenic will melt with the ore, and prevent its total volatilization ; in which case, perform the first sublimation with a moderate heat ; then bruise the remainder again, and expose it to a strong heat.

*In the humid way.* Digest the ore in marine acid, add the nitrous by degrees, to help the solution. The sulphur will be found on the filter ; the arsenic will remain in the solution, and may be precipitated in its metallic form by zinc, adding spirits of wine to the solution.

**Nickel Ore.** Roast the ores well, to expel the sulphur and arsenic ; the greener the calx proves during this torrefaction, the more it abounds in the nickel ; but the redder it is, the more iron it contains. Fuse in an open crucible, a proper quantity, with twice or thrice its weight of black flux, the whole covered with common salt. Expose the crucible to the strongest heat of a forge fire ; make the fusion complete, and it will produce a regulus, though not pure. It contains a portion of arsenic, cobalt, and iron. Deprive the first by fresh calcination, adding powdered charcoal ; the second, by scorification but it is difficult to free it entirely from iron.

*In the humid way.* By solution in nitrous acid, it is freed from its sulphur ; and by adding water to the solution, bismuth, if any, may be precipitated ; silver, also, if contained in it, by the marine acid ; and copper, when any, by iron.

To separate cobalt from nickel, when the cobalt is in considerable quantity, drop a saturated solution of the roasted ore in nitrous acid into liquid volatile alkali ; the cobaltic part is instantly redissolved, and assumes a garnet colour, when filtered, a grey powder remains on the filter, which is the nickel. The cobalt may be precipitated from the volatile alkali, by any acid.

**Cobalt Ores.** Free them as much as possible from earthy matters, by washing, and from sulphur and arsenic by roasting. When prepared mix the ore with three parts of black flux and a little decrepitated sea salt ; put the mixture in a lined

crucible, cover it, and place it in a forge fire, or hot furnace; for it is difficult of fusion. When well fused, a metallic regulus will be found at the bottom, covered with a scoria, of a deep blue colour; as almost all cobalt ores contain bismuth, this is reduced by the same operation as the regulus of cobalt; they are incapable of chemically uniting together, and are always found distinct from each other in the crucible. The regulus of bismuth having a greater specific gravity, is always at the bottom, and may be separated by a blow with a hammer.

*In the humid way.* Make a solution of the ore in nitrous acid, or aqua-regia, and evaporate to dryness; the residuum, treated with the acetous acid will yield to it the cobaltic part; the arsenic should be first precipitated, by the addition of water.

*Mercurial Ores.* The calciform ores of mercury are easily reduced without any addition. Put into the retort a quintal of ore, and a receiver luted on, containing some water—place the retort in a sand bath, give a sufficient degree of heat to force over the mercury which is condensed in the water of the receiver.

*Sulphurated Mercurial Ores.* They are assayed as above, by distillation; only, these ores require an equal weight of clean iron filings to be mixed with them; to disengage the sulphur, while the heat volatilizes the mercury, and forces it into the receiver. These ores should be tried for cinnabar, to know whether it will answer the purpose of extracting it from them; for this, take a determinate quantity finely powdered, put it into a glass vessel, expose to a gentle heat at first, gradually increased till nothing more is sublimed. By the quantity thus obtained, we may know whether the process will answer.

Sometimes the cinnabar is not of so lively a colour, as that which is used in commerce; it may be refined by a second sublimation, and if then too dark, it may be brightened by the addition of mercury, and sublimed again.

*Humid assay of Cinnabar.* Dissolve the stony matrix in nitrous acid, the cinnabar being disengaged, should be boiled in eight or ten times its weight of aqua-regia, composed of three parts nitrous, and one of marine acid. The mercury may be precipitated in its running form by zinc.

*Silver Ore.* Take the assay quantity finely pulverized;

roast it well in a proper degree of heat ; stir it often with an iron rod ; then add about double the quantity of granulated lead, put it in a covered crucible, place it in a furnace, raise the fire gently at first, gradually increasing it, till the metal begins to work. If it appears too thick, add a little more lead ; if it should boil too rapid, diminish the fire. By degrees the surface will be covered with a mass of scoria ; then carefully stir it with an iron hook heated, especially towards the border lest any of the ore should remain undissolved ; and if what is adherent to the hook, when raised from the crucible, melts quickly again, and the extremity of the hook, after it is grown cold, is covered with a thin, shining, smooth crust, the scorification is perfect ; but, on the contrary, if while stirring it, any considerable clamminess is perceived in the scoria, and when it adheres to the hook, though red hot, and appears unequally tinged, and seems dusty, or rough, with grains interspersed here and there, the scorification is incomplete ; in consequence of which, the fire should be increased a little, and what adheres to the hook should be gently beaten off, and returned with a small ladle into the crucible. When the scorification is perfect, the metal should be poured into a cone, previously rubbed with a little tallow, and when it becomes cold, the scoria may be separated by a few strokes of a hammer.

*In the humid way.* Boil vitreous silver ore in diluted nitrous acid, using about twenty-five times its weight, until the sulphur is quite exhausted. Precipitate the silver from the solution by marine acid, or common salt ; one hundred grains of this precipitate, contains seventy-five of real silver ; if it contains any gold, it will remain undissolved. Fixed alkalies precipitate the earthy matters, and the Prussian alkali will show if any other metal is contained in the solution.

*By cupellation.* Take the assay quantity of ore, roast and grind it with an equal portion of litharge, divide it into two or three parts, and wrap each up in a small piece of paper ; put a cupel previously seasoned under a muffle, with about six times the quantity of lead upon it. When the lead begins to work, carefully put one of the papers upon it, and after this is absorbed, put on a second, and so on till the whole is introduced ; then raise the fire, and as the scoria is formed it will be taken up by the cupel, and at last the silver will remain alone. This will be the produce of the assay, unless

the lead contains a small quantity of silver which may be discovered by putting an equal quantity of the same lead on another cupel, and working it off at the same time; if any silver be produced it must be deducted from the assay.

*To assay the value of Silver.* To ascertain the purity of silver, mix it with a quantity of lead proportionate to the supposed portion of alloy: test this mixture, and afterwards weigh the remaining button of silver. This is the same process as refining silver by cupellation.

Suppose the mass of silver to be examined, consists of twelve equal parts, called pennyweights; so that if an ingot weighs an ounce, each of the parts will be one-twelfth of an ounce. Thus, if the mass of silver be pure, it is called silver of twelve pennyweights; if it contains one-twelfth part of its weight of alloy, it is called silver of eleven pennyweights; if two-twelfths alloy, it is called ten pennyweights; which parts of pure silver are called fine pennyweights. Assayers give the name pennyweights, to a weight equal to twenty real grains, which must not be confounded with the ideal weights. Assayer's grains are called fine. An ingot of fine silver, or silver of twelve pennyweights, contains, then two hundred and eighty-eight fine grains; if this ingot contains one-two hundred eighty-eighth of alloy, it is silver of eleven penny-weights, twenty-three grains; if four-two hundred eighty-eighths of alloy, eleven pennyweights, twenty grains, &c. A certain real weight must be taken to represent the assay weights: for example, thirty-six real grains represent twelve fine pennyweights, this subdivided into a number of other smaller weights, represent fractions of fine pennyweights and grains. Thus, eighteen real grains represent six fine pennyweights, three real grains, one fine pennyweight, or twenty-four grains; a real grain and a half, represents twelve fine grains: one-thirty second of a real grain, represents a quarter of a fine grain, which is only one-seven hundred and fifty-second part of a mass of twelve pennyweights.

*Double assay of Silver.* The silver for the assay, should be taken from opposite sides of the ingot, and tried on a touchstone. Assayers know very nearly the value of silver by the look of the ingot; much better, by the test of the touchstone. The quantity of lead to be added is regulated by the portion of alloy, which is in general, copper: heat the cupel red hot for half an hour, before any metal is put upon

it, which expels all moisture. When it is almost white by heat, put in the lead, increase the heat till the lead becomes red hot, smoking and agitated by a motion of all its parts, called its circulation. Then, put the silver on the cupel, and continue the fire, till the silver enters the lead. When the mass circulates well, diminish the heat by closing more or less the door of the assay furnace. Regulate the heat, that the metal on its surface may appear convex and ardent, while the cupel is less red, that the smoke shall rise to the roof of the muffle, that undulations shall be made in all directions, and that the middle of the metal shall appear smooth, with a small circle of litharge, which is continually imbibed by the cupel. When the lead and alloy is entirely absorbed by the cupel, the silver becomes bright and shining, when it is said to lighten; when, if the operation has been well performed, the silver will be covered with rainbow colours, which quickly undulate and cross each other, and then the button becomes fixed and solid.

The diminution of weight shows the quantity of alloy. As all lead contains a small portion of silver, an equal weight with that assay, is tested off, and the product deducted from the assay weight. This portion is called the witness.

*To assay plated metals.* Take a determinate quantity of the plated metal; put it into an earthen vessel, with a sufficient quantity of the above menstruum, and place it in a gentle heat. When the silver is stripped, it must be collected with common salt; the calx tested with lead, and the estimate made according to the product of the silver.

*Ores and Earths containing Gold.* The general method is by amalgamation. Take a proper quantity, reduce it to powder, add about one-tenth of its weight of pure quicksilver, and triturate the whole in an iron mortar. The attraction which subsists between the gold and quicksilver, quickly unites them in the form of an amalgam, which is pressed through chamois leather; the gold is easily separated from this amalgam by exposure to a proper degree of heat, which evaporates the quicksilver and leaves the gold.

This evaporation should be made with luted vessels; and this is the foundation of all operations by which gold is obtained from the rich mines of Peru.

2. Heat red hot, a quantity of gold sand, quench it in water; repeat two or three times, and the colour of the sand will

become a reddish brown. Now mix it with twice its weight of litharge, and revive the litharge into lead, by adding a small portion of charcoal dust, exposing it to a proper degree of heat; when the lead revives, the gold is separated from the sand, and the freeing of the gold from the lead must afterwards be performed by cupellation.

Metallic ores containing gold are sometimes assayed as follows:—mix two parts of the ore, well pounded and washed, with one and a half of litharge, and three of glass: cover the whole with common salt; melt it in a smith's forge, in a covered crucible; then open the crucible, put a nail into it, and continue to do so till the iron is no longer attacked. The lead is thus precipitated which contains the gold, and is then separated by cupellation.

*Humid assay of Gold mixed with martial pyrites* Ore dissolved in twelve times its weight of diluted nitrous acid, gradually added: place it in a proper degree of heat; the soluble parts are taken up, and leaves the gold untouched, with the insoluble matrix, from which it is separated by aqua-regia. The gold is again separated from the aqua-regia by pouring ether upon it; the ether takes up the gold, and by being burnt off, leaves it in its metallic state. The solution may contain iron, copper, manganese, calcareous earth, or argil; if evaporated to dryness, and the residuum heated to redness for half an hour, volatile alkali will extract the copper; dephlogisticated nitrous acid, the earths; acétous acid, the manganese; and marine acid, the calx of iron. The sulphur floats on the first solution, from which it is separated by filtration.

*Parting of Gold and Silver.* Gold and silver equally resisting the action of fire and lead, must therefore be separated by other means, which is effected by different menstrua. Nitrous acid, marine acid, and sulphur, which cannot attack gold, operate upon silver, and these are the principal agents employed in the process of *parting*. Parting by nitrous acid is the most convenient; this is called *simple parting*, and is generally the method preferred by goldsmiths. That made by the marine acid is by cementation, and called *concentrated parting*; that by sulphur, is made by fusion, and called *dry parting*.

*Parting by Aqua-Fortis.* The following directions are to be regarded; first, must be in a proper proportion, viz. three parts of silver to one of gold, though a mass of silver containing two parts of silver to one of gold may be parted.



The quality of the metal is determined by assayers, who make a comparison upon a touchstone, between it and needles composed of gold and silver in graduated proportions, and properly marked, which are called *proof needles*. If the silver is not to the gold, as three to one, the mass is improper for the operation, unless more silver is added ; besides, the aqua-fortis must be very pure, containing neither vitriolic or marine acid. Granulate the metal previous to parting, by melting it in a crucible ; then pour it into a vessel of water, giving the water a rapid circular motion with a stick. The vessels used are called *parting glasses*, free from flaws, and well annealed. The glasses are apt to crack on exposure to cold, or when even touched by the hand. The bottoms are secured by some operators, by a coating made of new slacked lime, with beer and white of eggs spread on a cloth, and wrapped round the bottom, over which they apply a composition of clay and hair. The glasses are placed in vessels containing water, supported by trivets, with a fire under them : thus, if a glass breaks, the contents are caught in the vessel of water. If the heat communicated to the water is too great, regulate it by pouring cold water carefully down the side of the vessel into a parting glass fifteen inches high, and ten or twelve inches wide at the bottom, placed in a copper pan twelve inches wide at bottom, fifteen inches wide at top, and ten inches high ; assayers generally operate with about eighty ounces of metal, with twice as much aqua-fortis.

The aque-fortis should be so strong as to act sensibly on silver, when cold, but not violently. Apply but little heat at first, as the liquor is apt to swell and rise over the vessel : when the acid is nearly saturated, increase the heat. When the solution ceases (which is known by the effervescence discontinuing) pour the liquor off ; if any grains appear entire, add more aqua-fortis, till all the silver is dissolved. If the operation is performed slowly, the remaining gold will have distinct masses. The gold appears black after parting ; its parts have no adhesion together ; because the silver dissolved from it has left many interstices : to give them more solidity, and improve their colour, they are put into a test under a muffle, and made red hot ; after which they contract and become more solid, and the gold resumes its colour and lustre. It is then called *grain gold*. If the operation has been has-

tily performed, the gold will have the appearance of black mud or powder, which must be melted after well washing.

Recover the silver by precipitating it from aqua-fortis by means of pure copper. No precipitation will take place, if the solution is perfectly saturated, till a few drops of aqua-fortis are added. Wash the precipitate of silver well with boiling water, fuse with nitre and test off with lead.

*Parting by Cementation.* Bricks powdered and sifted, four parts ; one part green vitriol, calcined till it becomes red, and one part of common salt, made into a fine paste with a little water.

Reduce the gold to be cemented into plates as thin as money. Put at the bottom of the cementing pot, a stratum of the above paste, half an inch thick ; cover with plates of gold, and so the strata are placed alternately : cover the whole with a lid, which is luted with a mixture of clay and sand. Place the pot in a furnace or oven, heat gradually, till it becomes red hot ; keep it in the oven twenty-four hours ; the heat must not melt the gold ; then suffer the crucible to cool ; separate carefully the gold from the cement, and boil at different times in a large quantity of pure water. Then assay upon a touchstone or otherwise ; if not sufficiently pure, cement a second time.

In this process the vitriolic acid of the bricks, and the calcined vitriol, decomposes the common salt, during the cementation, by uniting to its alkaline base, while the marine acid becomes concentrated by the heat ; and dissolves the silver alloyed with the gold. This is a very troublesome process, though it succeeds, when the portion of silver is so small, that it would be defended from the action of aqua-fortis by the superabundant gold ; but is little used, except to extract silver, or base metals, from the surface of gold, and thus giving to an alloyed metal the colour and appearance of pure gold.

*Dry Parting.* As the dry parting is ever troublesome as well as expensive, it ought not to be undertaken, but on a considerable quantity of silver alloyed with gold. Granulate the metal ; from one-eighth to one-fifth (as it is rich or poor in gold) reserve ; mingle well the rest with an eighth of powdered sulphur ; put into a crucible ; keep a gentle fire, that the silver, before melting, may be thoroughly penetrated by the sulphur ; the sulphur will dissipate, if the fire is hastily urged. If to sulphuretted silver in fusion pure silver is added, the latter falls to the bottom, and forms there a distinct fluid, not miscible with the other. The particles of gold having no

affinity with the sulphuretted silver, are joined to the pure silver whenever they come in contact, and are thus transferred from the former into the latter, more or less perfectly, as the pure silver is more or less thoroughly diffused through the mixture. For this use a part of the granulated silver is reserved. Bring the sulphuretted mass into fusion, keep melting for nearly an hour in a covered crucible, throw in one-third of the reserved grains, which, when melted, stir the whole well, that the fresh silver may be distributed through the mixed, to collect the gold from it, which is performed by a wooden rod ; which repeat, till the whole reserved metal is introduced. The sulphuretted silver appears in fusion of a dark brown colour ; after it has been in fusion for some time, a part of the sulphur having escaped from the top, the surface becomes white, and some bright drops of silver, about the size of a pea, are perceived on it. When this takes place, the fire must be immediately discontinued, or more and more of the silver, thus losing its sulphur, would subside and mingle with the part at the bottom, (perhaps as much as was unsulphuretted from the mass,) by a chisel or hammer, or more perfectly by placing the whole mass with its bottom upwards in a crucible, the sulphuretted part quickly melts, leaving unmelted that which contains the gold. The sulphuretted silver is assayed by keeping a portion of it in fusion, till the sulphur is dissipated, and then by dissolving it in aqua-fortis.

If it should still be found to contain gold, it must be subjected to the same treatment as before. The gold thus collected may be concentrated into a smaller part, by repeating the whole process, when it may be parted by aqua-fortis without too much expense.

*To determine the quantity of Gold.* If its specific gravity is 17,157, it is lawful coin. The specific quality of pure gold is 19,3. Copper, silver, and most other metals which are alloyed with gold, may be easily separated from gold by nitric acid : for if the alloy be in fine filings, the nitric acid will dissolve the other metals, and leave the gold in a black powder. This powder may be separated and melted down in a pure mass ; but the common method adopted by artists is, to melt the alloy with sulphuret of antimony. The other metals become sulphurets, and the gold will unite with the antimony, and all fall to the bottom of the crucible. After cooling it may be separated. Now melt the alloy of gold and antimony, boil it at a white heat, and the antimony will become volatilized and fly off.

*To obtain Silver pure from Alloy.* Put some nitric acid in a wine glass diluted with an equal bulk of water ; drop into it a six cent piece, and let it remain till action ceases. Now take out the undissolved silver, and put in a plate, or a coat of perfectly clean bright copper. The silver will be precipitated after a short time. Wash the powder several times ; and put a little liquid ammonia into the water for the first washings. Now melt down the powder into a solid mass, which will be pure silver.

Silver coin is alloyed with copper as 12-1-3 to 1.

*Weight of metals:* Platina is twenty-three times heavier than water. Gold, nineteen ; silver, eleven ; quicksilver, fourteen ; copper, nine ; iron, eight ; tin, seven ; lead, eleven ; nickel, nine ; zinc, seven.

*Method of ascertaining the specific gravity of bodies.*—The instrument generally used for obtaining the specific gravities, is called the hydrostatical balance ; it does not differ much from the common balance. The way to find the specific gravity of a solid heavier than water, as a piece of metal is this : weigh the body first in air, in the usual way, then weigh it when it is plunged in water, and observe how much it loses of its weight in this fluid, and dividing the former weight by the loss sustained, the quotient is the specific gravity of the body, compared with that of water. A piece of gold may be tried by weighing it first in air, and then in water, and, if upon dividing the weight in air, by the loss in water, the quotient comes to be about seventeen, the gold is good ; if eighteen, or nearly nineteen, the gold is very fine ; if less than seventeen, it is too much alloyed with other metal. The same principle is universal. Hence we see the reason why boats or other vessels float on water ; they sink just so low, that the weight of the vessel, with its contents, is equal to the quantity of water which it displaces.

The method of ascertaining the specific gravity of bodies, was discovered by Archimedes. Hiero, king of Sicily, having given a workman a quantity of pure gold, to make a crown, suspected that the artist had kept part of the gold, and adulterated the crown with a base metal. The king applies to Archimedes, to discover the fraud. The philosopher long studied in vain, but at length he accidentally hit upon a method of verifying the king's suspicion. Going one day into a bath, he took notice that the water rose in the bath, and immediately reflected that any body of equal bulk with himself, would have raised the water just as much ; though a body of equal weight, but not of equal

bulk, would not raise it so much. From this idea he conceived a mode of finding out what he so much wished, and was so transported with joy, that he ran out of the bath crying out in the Greek tongue, "I have found it, I have found it." As gold was the heaviest of all metals then known, he therefore desired a mass of pure gold, equally heavy with the crown when weighed in air, should be weighed against it in water, conjecturing that if the crown was not alloyed it would counterpoise the mass of gold when they were both immersed in water, as well as it did when they were weighed in air. On making trial, the mass of gold weighed much heavier in water than the crown did, nor was this all; when the mass and crown were immersed separately in the same vessel of water, the crown raised the water much higher than the mass did, which showed it was alloyed with some other lighter metal which increased its bulk.

On this principle is founded the doctrine of the specific gravities of bodies.

Half of the civilized employments of man, consists in working the metals, and minerals; civilization depends so much on the discovery of the useful metals, that little progress can be made from a savage state, without the useful trade of a blacksmith.

To avoid the inconveniences of exchanging or bartering, men, in earlier ages fixed on metals; as on gold, silver, copper or iron, for a medium of value, so that if one man had too much corn and wanted wine, he was obliged to give corn for wine, but he might sell his corn for metal, and buy the wine with the metal, at his convenience. Hence the origin of money; as it was found inconvenient to weigh metal in every transaction, (as Abraham did when he bought the burying place for Sarah,) stamps were put on pieces of metal to indicate that they might be safely received for a settled weight or value.

Viewing the metals in ordinary use, we consider them common productions; but no art is so curious as that of extracting metals from the earth, or ore, in which they are buried or concealed; and no discovery or invention was ever more wonderful. Workers of metal imitate nature, when they beat and wash their ores. No one on looking at most of the metallic ores, would suspect them to contain metals, as they are apparently the roughest, coarsest, and least desirable stones on earth. Research is on the wing of activity, and discoveries of minerals of the greatest utility are daily making. We are willing to believe there are still in reserve, beneath the surface of the earth, in our own country, *golden treasures* for the enterprising; if not near our most frequent walks, yet

in very many places which have never experienced the probing effects of a crowbar, or the pressure of the foot of man.

## CHAPTER XVII.

*The art of Working Metals—Compounds of Metals—Useful Alloys—Conversion of Iron into Steel—to colour Metals—to burn Metals—to refine pewter—So'ders—bronze—of temporing edge tools—test for metals—to tin iron and copper vessels.*

*Method of reducing Iron Ore into malleable Iron.* We proceed by stamping, washing, &c. the calcine and materials, to separate the ore from extraneous matter; then fusing the prepared ore in an open furnace, and instead of casting it, to suffer it to remain at the bottom of the furnace till it becomes cold.

*New method of shingling and manufacturing Iron.* The ore being fused in a reverberating furnace, is conveyed, whilst fluid, into an air furnace, where it is exposed to a strong heat, till a bluish flame is observed on the surface; it is then agitated on the surface, till it looses its fusibility, and is collected into lumps called *loops*. These loops are then put into another air furnace, brought to a white or welding heat, and then *shingled* into *half-blooms* or *slabs*. They are again exposed to the air furnace, and the half-blooms taken out and forged into *anconies*, *bars*, *half-flats*, and *rods* for *wire*; While the slabs are passed, when of a welding heat, through the grooved rollers. In this way of proceeding, it matters not, whether the iron is prepared from cold or hot short metal, nor is there any occasion for the use of finery, charcoal, coke, chafery, or hollow fire, or any blast by bellows, or otherwise: or the use of fluxes in any part of the process.

*To weld Iron; an improved method.* This consists in the skilful bundling of the iron to be welded; in the use of an extraordinary large forge hammer; in employing a *balling furnace*, instead of a *hollow fire* or *chafery*; and in passing the iron, reduced to a melting heat, through grooved mill-rollers of different shapes and sizes, as required.

*Common hardening.* Iron by being heated red hot, and plunged into cold water, acquires a great degree of hardness. This proceeds from the coldness of the water which contracts the particles of the iron into less space.

*Case hardening.* Is a superficial conversion of iron into steel, by cementation. It is performed on small pieces of iron, by enclosing them in an iron box, containing burnt leather, bone dust, or any other carbonic material, and exposing them for some time to a red heat. The surface of the iron thus becomes perfectly metalized. Iron thus treated is susceptible of the finest polish.

*To convert Iron into Steel by Cementation.* The iron is formed into bars of convenient size, and then placed in a cementing furnace, with a sufficient quantity of cement which is composed of coals of animal or vegetable substances, mixed with calcined bones, &c. The following are very excellent cements; 1. One part of powdered charcoal, one half a part of wood ashes, well mixed together. 2. Two parts charcoal moderately powdered, one part of bones, horn, hair or skins of animals, burnt in close vessels to blackness and powdered; and half a part of wood ashes; mix them well together.—The bars of iron to be converted into steel, are placed upon a stratum of cement, and covered all over with the same; and the vessel which contains them, closely luted, must be exposed to a red heat for eight or ten hours, when the iron will be converted into steel.

Steel is prepared from bar iron by fusion; which consists in plunging a bar into melted iron, and keeping it there, for some time, by which process it is converted into good steel. All iron which becomes harder by suddenly quenching in cold water, is called steel; and that steel which in quenching acquires the greatest degree of hardness in the lowest degree of heat, and retains the greatest strength in and after induration, ought to be considered as the best.

*Improved process of hardening Steel.* Articles manufactured of steel, for the purpose of cutting, are, almost without an exception hardened from the anvil; in other words, they are taken from the forger to the hardener, without undergoing any intermediate process; and such is the accustomed routine, that the mischief arising has escaped observation. The act of forging produces a strong scale or coating, which is spread over the whole of the blade; and to make the evil still more formidable this scale or coating is unequal in substance, varying in proportion to the degree of heat communicated to the steel in forging; it is, partially, almost impenetrable to the action of water when immersed for the purpose of hardening. Hence it is that different degrees of hardness prevail in every razor manufactured; this is evidently a positive defect; and

so long as it continues to exist, great difference of temperature must exist likewise. Razor blades not unfrequently exhibit the fact here stated in a very striking manner; what are termed clouds, or parts of unequal polish, derive their origin from this cause; and clearly and distinctly, or rather *distinctly*, though not *clearly* show how far this partial coating has extended, and when the action of water has been yielded to, and when resisted. It cannot be matter of astonishment; that so few improvements have been made in the hardening of steel, when the evil here complained of, so universally obtains, as almost to warrant the supposition that no attempt has ever been made to remove it. The remedy, however, is easy and simple in the extreme, and so evidently efficient in its application, that it cannot but excite surprise, that in the present highly improved state of our manufactures, such a communication should be made as a discovery entirely new. Instead, therefore, of the customary mode of hardening the blade from the anvil, let it be passed immediately from the hands of the forger to the grinder; a slight application of the stone will remove the whole of the scale or coating and the razor will then be properly prepared to undergo the operation of hardening with advantage. It will be easily ascertained, that steel in this state, heats in the fire with greater regularity, and that when immersed, the obstacles being removed to the immediate action of the water on the body of the steel, the latter becomes equally hard, from one extremity to the other. To this may be added, *that as the lowest possible heat at which steel becomes hard, is indubitably the best*, the mode here recommended will be found the only one by which the process of hardening can be effected with a less portion of fire than is or can be required in any other way. These observations are decisive, and will in all probability, tend to establish in general use, what cannot but be regarded as a very important improvement in the manufacturing of edged steel instruments.

*English Cast Steel.* The finest kind of steel, called *English cast steel*, is prepared by breaking to pieces blistered steel, and then melting it in a crucible with a flux composed of carbonaceous and vitrifiable ingredients. The vitrifiable ingredient is used only inasmuch as a fusible body, which flows over the surface of the metal in the crucible, and prevents the access of the oxygen of the atmosphere. Broken glass is sometimes used for this purpose.



When thoroughly fused it is cast into ingots, which by gentle heating and careful hammering, are tilled into bars. By this process the steel becomes more highly carbonized in proportion to the quantity of flux, and in consequence is more brittle and fusible than before. Hence, it surpasses all other steel in uniformity of texture, hardness, and closeness of grain, and is the material employed in all the finest articles of English cutlery.

*To make edge tools from Cast Steel and Iron.* This method consists in fixing a clean piece of wrought iron, brought to a welding heat, in the centre of a mould, and then pouring in melted steel, so as entirely to envelop the iron; and then forging the mass into the shape required.

*To colour Steel Blue.* The steel must be finely polished on its surface, and then exposed to an uniform degree of heat. There are three ways of colouring: first, by a flame producing no soot, as spirit of wine; secondly, by a hot plate of iron; and thirdly, by wood ashes.

As a very regular degree of heat is necessary, wood ashes for fire work bears the preference. The work must be covered over with them, and carefully watched; when the colour is sufficiently heightened, the work is perfect. This colour is occasionally taken off with a very diluted marine acid.

*Useful alloy of Gold and Platinum.* Seven and a half dr. pure gold, and half dr. platinum. The platinum must be added when the gold is perfectly melted. The two metals will combine intimately, forming an alloy rather whiter than pure gold, but remarkably ductile and elastic, it is also less perishable than pure gold, or jeweller's gold, but more readily fusible than that metal.

These qualities must render this alloy an object of great interest to workers in metals. For *springs* when steel cannot be used, it will prove exceedingly advantageous.

It is a curious circumstance, that the alloy of gold and platinum is soluble in nitric acid, which does not act on either of the metals in a separate state. It is remarkable, too, that the alloy has very nearly the color of platinum, even when composed of eleven parts of gold to one of the former metal.

*Ring Gold.* Six dwts. twelve grs. Spanish copper, three dwts. sixteen grs. fine silver, and one ounces five dwts. gold coin.

**Tomback:** Sixteen lbs. copper, one lb. tin, and one pound zinc.

**Red Tomback.** Five and a half pounds copper, and half a pound zinc. The copper must be fused in a crucible before the zinc is added. This alloy is of a reddish colour and possesses more lustre and is of greater durability than copper.

**White Tomback.** Copper and arsenic put together in a crucible, and melted, covering the surface with muriate of soda, to prevent oxydation, will form a white bright alloy.

**Gun Metal.** 1. One hundred twelve pounds Bristol brass, fourteen pounds blocktin. 2. Nine parts copper, and one part tin. The above compounds are those used in the manufacture of small and great brass guns, swivels, &c.

**Specula of Telescopes.** Seven pounds copper, and when fused, add three pounds of zinc, and four lbs. of tin. These metals will combine and form a beautiful alloy of great lustre, and of a light yellow colour, fitted to be made into specula for telescopes. Some use only copper and grain tin in the proportion of two lbs. to 14 2-2 oz.

**To distinguish Steel from Iron.** Let fall one drop of nitric acid upon a piece of polished iron, and another upon a piece of polished steel. The acid on the iron will be limpid or whitish, that on the steel will become dark brown or black.

It is not necessary to polish the iron or steel to try its hardening qualities—if a spot on a coarse bar of iron or steel be filed bright it will be sufficient.

**Compounds of Metals.** Four ounces of bismuth; two oz. and a half lead; and one ounce and a half tin. Put the bismuth into a crucible, and when it is melted, add the lead and tin. This will form an alloy fusible at the temperature of boiling water.

2. Zinc, bismuth, lead; of each one ounce.

This alloy is so very fusible, that it will remain in a state of fusion if put on a sheet of paper and held over the flame of a candle or lamp.

3. Lead, three parts; tin, two parts; bismuth, five parts; will form an alloy fusible at 197 deg. Fahrenheit, peculiarly applicable to casting, or the taking of impressions from gems, seals, &c. In making casts with this and similar alloys, it is necessary to use the metal at as low a temperature as possi-

ble; otherwise the water adhering to the things from which the casts are to be taken, forms vapour, and produces bubbles. The fused metal should be poured into a teacup, and allowed to cool, till just ready to set at the edges, when it must be poured into the mould. In taking impressions from gems, seals, &c. the fused alloy should be placed on paper or pasteboard, and stirred about till it has, by cooling, attained the consistence of paste, at which moment the die, gem, or seal should be stamped on it, and a very sharp impression will be obtained.

*Bath Metal*, is a mixture of four ounces and a half of zinc, and one pound of brass.

*Brass*, is composed of 4 1-2 pounds copper: 1 1-2 pounds of zinc.

Brass that is to be cast into plates from which pans and kettles are to be made and wire is to be drawn, must, instead of using the zinc in a pure state, be composed of fifty-six pounds of the finest calamine, or ore of zinc; and thirty-four pounds of copper. Old brass which has been frequently exposed to the action of fire, when mixed with copper and calamine, renders the brass far more ductile, and fitter for making fine wire, than it would be without it; but the German brass, particularly that of Nuremburgh, is, when drawn into wire, said to be far preferable to any made in England, for the strings of musical instruments.

*Pinchbeck*. Three ounces of pure copper, and one ounce of zinc. The zinc must not be added till the copper is in a state of fusion. Some use only half this quantity of zinc, in which proportion the alloy is more easily worked, especially in the making of jewelry.

2. One ounce of brass: and two ounces of copper, fused together under a coat of charcoal dust.

*Prince's Metal*. 1. Three ounces of copper, and one oz. of zinc; or 8 oz. of brass, and 1 of zinc.

2. Four oz. of copper, and 2 oz. of zinc. In this last the copper must be fused before the zinc is added; when they have combined, a very beautiful and useful alloy is formed called Prince Rupert's Metal.

*Bell Metal*. Six parts of copper and two parts of tin.

These preparations are the most approved for bells, throughout Europe and in China. In the union of the two metals the combination is so complete, that the specific gravity of the

alloy is greater than that of the two metals in an uncombined state.

2. Ten parts of copper, and two parts of tin. It may in general be observed, that a less proportion of tin is used for making churchbells, than clockbells; and that a little zinc is added for the bells of repeating watches, and other small bells.

*Tutania, or Britannia Metal.* Four oz. of plate brass, and four oz. of tin; when in fusion, add four ounces bismuth and four ounces regulus of antimony. This is the composition, or hardening that is to be added at discretion, to melted tin, until it has acquired the requisite degree of colour and hardness.

2. Melt together, two pounds of plate brass; two pounds of tin; two pounds of bismuth; two pounds of regulus of antimony; two pounds of a mixture of copper and arsenic, either by cementation or melting. This composition is to be added to melted tin.

3. One pound copper, 1 do. tin, and 2 do. regulus of antimony with or without a little bismuth.

4. Eight oz. of shruff brass; 2 lbs. regulus of antimony; and 12 oz. of tin.

*German Tutania.* Two drachms of copper; one oz. regulus of antimony; and twelve oz. of tin.

*Spanish Tutania.* Eight ounces scrap iron, or steel; one pound antimony; and three ounces nitre. The iron or steel must be heated to a white heat, and the antimony and nitre must be added in small portions. Melt and harden 1 pound tin with 2 oz. of this compound.

2. Melt together 4 oz. antimony, 1 oz. of arsenic and 2 lbs. tin. The first of these Spanish alloys would be a beautiful metal, if arsenic were added.

*Engestroom Tutania.* Four parts copper, eight parts regulus of antimony, and one part bismuth: when added to one hundred parts of tin, this compound will be ready for use.

*Queen's Metal.* Four and a half pounds tin, half a pound bismuth, half a pound antimony, half a pound lead. This alloy is used for making tea-pots and other vessels which are required to imitate silver. It retains its lustre to the last.

2. One hundred pounds tin, 8 pounds regulus of antimony, 1 pound bismuth, and 4 do. copper.

*White Metal.* Ten oz. lead, 6 oz. bismuth, and 4 drachms regulus of antimony.

2. Two pounds regulus of antimony; 8 oz. of brass; and 10 oz. tin.

*Common Hard White Metal.* One pound brass, 1 1-2 oz. zinc, and half an ounce of tin.

*Metal for Tinning.* To one pound malleable iron, at white heat, add five ounces regulus of antimony; and twenty-four pounds of the purest Molucca tin. This alloy polishes without the blue tint, and is free from lead or arsenic.

*Metal for Flute Key Valves.* Four ounces lead, and two ounces antimony, fused in a crucible and cast into a bar. It is used by flute manufacturers (when turned into small buttons in a lathe) for making valves to stop the key holes of flutes.

*To Burn Metals.* Procure a glass jar, such as is generally used for defflagrating the gases, and fill it with oxymuriatic acid gas. If nickel, arsenic, or bismuth in powder, be thrown into this gas, and the temperature of the atmosphere be not lower than 70 deg. the metal will inflame, and continue to burn with the most brilliant combustion.

Prepare a jar of chlorine, (oxymuriatic gas) and suspend in it a piece of copper foil; it will immediately inflame, and afford a very striking spectacle. When subsided, it will form a substance exactly similar to the native muriate of copper, brought from Peru.

2. Make a hole in the side of a large piece of charcoal; put into it some iron filings, iron wire, zinc shavings, lead shavings, &c.; fill a glass-holder with oxygen, provided with a tin or lead tube, terminating in a pipe stem; hold the charcoal in a suitable position to receive the current of oxygen upon the metals. Let an assistant hold the flame of a candle between the metals and the pipe, till the current of oxygen drives the flame into the coal; then remove the candle and continue the current of oxygen, enlarging or contracting it at pleasure, by turning the stop. The metals will burn very brilliantly; each exhibiting its own peculiar flame.

3. Coil up a piece of fine iron wire about the size of sowing thread; wind it spirally and closely around a pipe stem; let the coil be three or four inches long; the upper end fitted into a cork, which suits the mouth of an eight ounce phial. Fill the phial nearly with oxygen, leaving water in it to cover the bottom an inch thick, in order to defend it from being broken with the globules of hot oxide of iron which fall upon

it: set the phial on the table, well stopped with another cork: now tie a small knot of silk thread on the lower end of the coil; hold a piece of brimstone in a candle till it melts a small spot; blow out the blaze of brimstone, and dip in the knot of thread. Be certain that the thread and melted brimstone which adheres to it, do not exceed in size a large pin head. Now pull out the cork; hold the thumb over the mouth, and let an assistant steady the phial; light the brimstone match; put the coil of wire quickly into the phial, fitting in the cork to which it is attached: the metal will soon send off brilliant sparks, and make a beautiful exhibition.

4. If a piece of wire, about twice as large as the wire of the coil, be flattened with a hammer, and fitted into the cork, so as to extend down through the centre of the coil, and set on fire at the same time, in the same manner with the coil, it will present a very curious appearance: the central wire will burn with a large globular flame, while a smaller globular flame will perform evolutions around it, resembling the motion of a planet while revolving around the sun.

We are taught by the foregoing experiment, if the oxygen of the air was not reduced in power by hydrogen, iron itself would not resist combustion.

*To Refine Pewter.* Take fine pewter, melt it in a crucible. When done, project over it at several times some nitre, till you see it calcined. Then pound it into powder, and mix it with an equal quantity of charcoal pulverized very fine. If in this condition you melt it again, it will resume its form of pewter, only refined in a much superior degree.

*Common Pewter.* Seven pounds tin, one pound lead, six oz. copper, and two oz. zinc. The copper must be fused before the other ingredients are added.

*Best Pewter.* One hundred parts tin, and 17 parts regulus of antimony.

*Hard Pewter.* Twelve pounds tin, 1 do. regulus of antimony, and four ounces copper.

*Common Solder.* Two pounds lead, and one pound tin. The lead must be melted before the tin is added.

This alloy, when heated by a hot iron, and applied to tinned iron with powdered rosin, acts as a cement or solder; it is also used to join leaden pipes.

*Soft Solder.* Two pounds tin, and one pound lead.

*Solder for Steel Joints.* Nineteen pennyweights fine

silver, one pennyweight copper, and two pennyweights brass, melted together under a coat of charcoal dust.

This solder has several advantages over the usual zinc solder, or brass, when employed in soldering cast steel, &c. as it fuses with less heat, and its whiteness has a better appearance than brass.

*Silver Solder for Jewellers.* Nineteen pennyweights of fine silver, one pennyweight copper, and ten pennyweights brass.

*Silver Solder for Plating.* Ten pennyweights brass, and one ounce pure silver.

*Gold Solder.* Twelve pennyweights pure gold, two dwts. pure silver, and four dwts. copper.

*Brass Solder for Iron.* Thin plates of brass are to be melted between the pieces that are to be joined. If the work be very fine, as when leaves of a broken saw are to be brazed together, cover it with pulverized borax, melted with water, that it may incorporate with the brass powder, which is added to it; the piece must then be exposed to the fire, without touching the coals, and heat it till the brass is seen to run.

*Bronze.* Seven pounds pure copper, three pounds zinc, and two pounds tin. The copper must be fused before the other ingredients are added. These metals, when combined, form the bronze so much used, both in ancient and modern times.

*Mock Platina.* Melt together, eight ounces brass, and five ounces zinc.

*Powder Gold.* Verdigris, eight ounces, tutty, four ounces, borax, nitre, of each two ounces, corrosive sublimate, two drachms, made into a paste with oil, and melted together: used in japan work, as a gold colour.

*True Gold Powder.* Grain gold, one ounce, quicksilver nearly boiling, six ounces; rub together; then either distil off the quicksilver, or corrode it away with spirits of nitre, and heat the black powder that is left red hot.

2. Grain gold, one ounces, dissolve in a mixture of spirit of nitre, sixteen ounces, with common salt, four ounces; add to the clear solution, green vitriol, four ounces; dissolve in water; wash the precipitate, and heat it red hot.

3. Dissolve gold in aqua-regia, and draw off the acid by distillation; used in painting, gilding, &c.

*Tutenag.* Bismuth, one pound, tin, two pounds ; melt together : used for buttons and vessels.

*Tin and Copper.* Scrape a piece of copper well with a knife, and rub it over with sal ammoniac; then heat the copper over clean coals, which will not emit any smoke ; at the same time rubbing it over with rosin. While hot and thus cleansed with the sal ammoniac and rosin, rub tin upon it in its solid state, which being melted to the heat of the copper, will adhere to it, giving it a silvery white surface.

Copper vessel are tinned inside by a similar process; and any ingenious person may repair them in this way when the tin has rubbed off.

*Method of tempering edge tools that are of too brittle a quality.* Plunge them into boiling fat for two hours, then take them out, and let them cool gradually. They will retain their hardness without being brittle.

*Transmutation of Iron into the finest German Steel.* Take clean soot, one pound, oak wood ashes, twelve ounces, and four ounces of pounded garlies. Boil all together in twelve pounds common water, till reduced to four pounds. Strain this, and dip in it the iron pigs, which you will afterwards stratify with the following cement, viz : Take burnt wood coals, otherwise called *cokes*, and quick lime of each three pounds, soot dried and calcinated in an iron pan, one pound, decrepitate salt, four ounces. Make of this and your iron several beds alternately, one over another ; and having well luted the vessel in which you shall have made those beds of iron and cement, give them a reverberating fire, for three times twenty-four hours, and the operation is done.

*Of Zinc or Spelter, and its various uses.* Zinc combined with gold in equal proportions, forms a hard white compound metal, that admits of a fine polish, and may be advantageously manufactured into specula for optical instruments.

Zinc and tin melted together form a kind of pewter.

Spelter and copper readily unite in the fire, provided the combustion of the former be carefully prevented during the process. In this state it forms a metal distinguished by the name of yellow copper ; but which is divided into several sorts according to the respective proportions contained in the alloy. Thus three parts of copper and one of zinc, constitute brass, five or six of copper and one of zinc, form pinch-back. Tombac is composed of a still larger proportion of copper than pinchback; is of a deep red, and bears the name



of sit inventor. Prince's metal requires a still larger proportion of zinc than either of the proceeding compositions.

*Test for Metals.* Let a stream of sulphuretted hydrogen gas pass into a phial of liquid ammonia; the best method is to put the ammonia into a broad mouthed phial, filling it about half full; turn the phial in an oblique position, and extend the beak of the retort to the bottom of it. Wet tow may be wound about the neck of the retort when it enters the mouth of the phial to prevent the escape of the gas; or if a little does escape it is immaterial, for we should become sufficiently acquainted with this gas to detect it by its smell; now pour some of the liquid into a solution of copperas and another of blue vitriol.

For many metals this is a perfect test; precipitates all metallic solutions with such different colours, when applied as a test, that, with collateral tests, almost any metal may be detected.

*To give tools such a temper as will enable them to saw marble.* Make the tool hot in the fire, and when red cherry colour, take it off from the fire, rub it with a piece of candle, and steep it immediately in good strong vinegar, in which some soot must be diluted.

*The transmutation of Iron into Damask Steel.* You must at first purge it of its usual brittleness; and after having reduced it into filings, make it red hot in to crucible; steep it several times in oil of olives, in which you shall have before thrown melted lead. Take care to cover the vessel in which the oil is contained, every time you throw the steel into it, for fear the oil should catch fire.

*To whiten Brass.* Barss, copper, iron, or steel may be easily whitened, by means of the Cornwall tin, or pewter, prepared with sublimate, proceeding as follows: Take Cornwall pewter, about one pound, add to it half that quantity of sublimate. Set it on a strong fire and sublime. Throw away the first water; the second is good, which you know by its white colour. Now if you make a piece of copper, brass, steel or iron, it is not material which, red hot and steep it in that water it will become as white as silver.

*To calcine Pewter, and render it as white and as hard as silver.* Melt well pour pewter in a crucible, so that it may be very fine and clear; your it afterwards into a very strong vinegar, then into mercurial water; repeat that operation as

many times as you please, you will each time give it an additional degree of hardness and whiteness drawing near to silver, so much that it will at last be very difficult to distinguish from silver.

*To render Iron as white and as beautiful as Silver.* Take ammoniac salt in powder, and mix it with an equal quantity of quicklime. Put them all together in cold water and mix well; when done, any iron piece which you shall have made hot, will if you steep it in that prepared water, become as white as silver.

*To prevent Iron from rusting.* Warm your iron till you cannot touch it without burning yourself. Then rub it with new and clean white wax. Put it again to the fire till it has soaked in the wax. When done, rub it over with a piece of serge, and the iron will never rust.

*To Soften Iron and harden it more than it was before.* Make a little chink lengthways in an iron bar, in which pour melted lead. Then make it evaporate by a strong fire, as that of copelling; renew this operation four or five times, and the bar will become very soft. You harden it afterwards by steeping it, when red hot, in mere forge water, and it will be of so good a temper as to be fit for lancets, razors and knives, with which you will be able to cut other iron without its splitting or denting.

It has been found by experience that an armour can never be good proof against fire arms, if it has not first been softened with oils, gums, wax, and other increative things, and afterwards hardened by steeping them several times over in binding waters.

*To preserve the brightness of Arms.* Rub them with harts marrow, or else dissolve some alum powder, with the strongest vinegar you can find, and rub your arms with it. By this means they keep for ever bright.

*Tin alloyed with Copper.* Scour a very thin slip of iron bright, which while doing, dip it several times in very dilute sulphuric acid; bend one end of it so that it will fit the bottom of a crucible. Melt some tin in the crucible and dip the bent end of the slip of iron into it; the tin will combine with the surface of the iron, and if very thin will penetrate entirely through it.

On this principle sheet tin is manufactured.

*Chinese Sheet Lead.* The operation is carried on by

two men; the one is seated on the floor, with a large flat stone before him, and with a moveable flat stone standing at his side. His fellow workman stands by his side with a crucible filled with melted lead; and having poured a certain quantity upon the stone the other lifts the moveable stone, and dashing it on the fluid lead, presses it out into a flat and thin plate which he instantly removes from the stone. A second quantity of lead is poured in a similar manner, and a similar plate formed, the process being carried on with singular rapidity. The rough edges of the plates are then cut off, and are soldered together for use.

This method has been applied with great success to the formation of thin plates of zinc; for galvanic purposes:

*To cover bars of Copper, &c. with Gold, so as to be rolled out into sheets.* Prepare ingots or pieces of copper or brass in convenient lengths and sizes—clean them from impurity, making their surfaces level: now prepare plates of pure gold, or gold mixed with a portion of alloy, of the same size of the ingots of metal, and of suitable thickness. Having placed a piece of gold upon an ingot intended to be plated; hammer and compress them together, so that they may have their surfaces as nearly equal to each other as possible: now bind them together with wire, in order to keep them in the same position during the process required to attach them; now take silver filings, and mix with borax, to assist the fusion of silver; lay the mixture upon the edge of the plate of gold, and next to the ingot of metal. Having thus prepared the two bodies, place them on a fire in a stove or furnace; and let them remain until the silver and borax placed along the edges of the metals melt, and until the adhesion of the gold with the metal is perfect; then take the ingot carefully out of the stove, and by this process it is plated with gold, and prepared ready for rolling into sheets.

*To plate Iron.* 1. Polish the surface very clean and level with a burnisher; and afterwards by exposing it to a blueing heat, a silver leaf is properly placed, and carefully burnished down. This is repeated till a sufficient number of leaves are applied to give the silver a proper body.

2. By the use of solder: slips of thin solder are placed between the iron and silver, with a little flux, and secured together by binding wire. It is then placed in a clean vessel, and continued in it till the solder melts; when it is taken out and on cooling is found to adhere firmly.

3. By tinning the iron first, and uniting the silver by the intermediate slips of rolled tin, brought into fusion in a gentle heat.

*To Tin Copper and Brass.* Boil six pounds cream tartar four gallons water, and eight pounds grain tin, or tin shavings. After they have boiled a sufficient time, the substance to be tinned is put therein, and the boiling continued, when the tin is precipitated in its metallic form.

*To Tin Iron and Copper Vessels.* The iron to be tinned must be previously steeped in acid materials, such as sour whey, distiller's wash, &c. then scoured and dipped in melted tin, having been first rubbed over with a solution of sal ammoniac. The surface of the tin is prevented from calcining, by covering it with a coat of fat. Copper vessels must be well cleansed; and then a sufficient quantity of tin, with sal ammoniac, is put therein, and brought into fusion, and the copper vessel moved about. A little resin is sometimes added. The sal ammoniac prevents the copper from scalding, and causes the tin to be fixed wherever it touches. Lately, zinc has been proposed for lining vessels, instead of tin, to avoid the consequences which are unjustly apprehended.

*White Metal.* Ten oz. lead, six oz. bismuth, and four oz. regulus of antimony.

2. Two lbs. regulus of antimony, eight oz. brass, and ten oz. tin.

*Common hard White Metal.* Eight oz. copper, and half an oz. neutral arsenical salt, fused together, under a flux composed of calcined borax, charcoal dust, and fine powdered glass.

*Manheim Gold.* Three and a half oz. copper, one and a half oz. brass, and fifteen grs. pure tin.

*Imitation of Silver.* Three fourths oz. tin, and one lb copper, will make a pale bell metal which will roll and ring very near to sterling silver.

*Yellow dipping Metal.* Two parts Cheadle brass, one part copper, with a little Bristol old brass, and one-fourth of an ox. of tin to every pound of copper. This alloy is almost of the colour of gold coin. Cheadle brass is the darkest, and gives the metal a greenish hue. Old Bristol brass, is pale and yellow.

*Common Jewelry.* Three parts copper, one part Bristol old brass, and four oz. of tin to every pound of copper.

If this alloy is for fine polishing, the tin may be omitted and a mixture of lead and antimony substituted. Paler polishing metal, by reducing the copper to two, or to one part.

### CHAPTER XVIII.

*Glass—Discovery—Process of Manufacture—Gilding—Silvering—To separate Gold from gilt Copper or Silver—Oil-gilding on Wood—To gild by burnishing—By Amalgamation—To silver by heat—In the cold way—To plate Looking-Glasses—Gold and Silver Inks—To prepare metallic Trees—To whiten Foils—To colour Foils—To give Foils a lustre like Diamonds—Laquers.*

It is controverted among naturalists, to what class of bodies glass should be referred ; some make it a concrete juice, others a stone, and others again rank it among semi-metals ; but Dr. Merret observes, that these are all natural productions ; whereas glass is a factitious compound, produced by fire, and never found in the earth, but only the sand and stones that form it ; but metals are perfectly formed by nature into certain species, and fire only produces them by its faculty of separating heterogeneous, and uniting homogeneous bodies ; whereas it produces glass by uniting heterogeneous matters, viz. salt and sand, of which it evidently consists. The chief characters or properties of glass are, that it fuses in a vehement fire ; when fused, adheres to iron ; does not waste in the fire, is ductile, but not malleable ; and while red hot can be cast into any shape. It is friable when cold ; diaphanous, either hot or cold ; flexible and elastic ; disunited and broke by cold and moisture, and especially by saline liquors ; is only cut by the diamond or emery ; acid or other juices extract no quality from it ; it does not wear by the longest use, nor will any liquor make it musty, change its colour, or rust ; it softens metals and makes them fusible ; receives all metallic colours externally and internally ; will not calcine, and may be cemented like stones and metals. It is said 100 weight of sand in the composition yields 150 of glass. The salt is procured from the ashes of a water plant called kali.

There are many other plants besides kali, which produces a salt fit for glass. The sand or stones is the second ingredient, and what gives it the body ; they must be such as will fuse ; the whitest are the best, consequently, crystals are

preferred to all others. Sometimes manufacturers use a sort of pebble resembling white marble. Flints make a pure crystalline metal. When stones cannot be had conveniently, sand is used. The glass houses in England are furnished with a fine white sand, as is frequently used for sand boxes, with a coarser kind for green glass. For crystal glass, 200 pounds sand or stone are mixed, finely pulverized, with 130 of salt; they are then calcined in a reverberatory furnace for several hours. When the process is completed, it is called *frit* or *ballito*. This frit is set off in melting pots in the working furnace, with some manganese added, which destroys the greenish cast natural to all glass. While it is in fusion the workman mixes the metal well together; skimming off the sand, over which is a white salt, called sandiver, which, if suffered to remain, would render the glass brittle and unfit to work. When the vitrification is completed, and the metal sufficiently clear, it is formed into the articles required, by dipping a hollow iron into the melting pot, with which a sufficient quantity is taken out for the intended work: while red hot, it is rolled on a marble to unite its parts more firmly, then blowing moderately, swells it, repeating it until of sufficient size, then the artist, by whirling it about, lengthens and cools the glass; moulds it in the stamp irons, and flats the bottom, by pressing it on the marble; after which it is fashioned as occasion requires, after being broken from the blowing iron. As the workman finishes them, another takes them up with an iron fork, and places them in a tower over the melting furnace to anneal, where, after remaining some time, they are put into pans, which are gradually withdrawn to cool. There is scarcely a branch of manufacture, which deserves more attention than that of glass; and although the art has excited the astonishment of the world, still it is highly probable, that in order to bring it to the highest state of perfection, there is abundant room for much improvement.

Pliny relates that "glass was first discovered by accident in Syria, at the mouth of the river Belus, by certain merchants driven thither by the fortune of the sea, and obliged to continue there, and dress their victuals by making a fire on the ground, where there was an abundance of the herb kali: the plant burning to ashes, its salt incorporating with the sand and stones, became vitrified."

Some writers assert that the discovery of glass is as ancient

as the art of pottery or making brick ; for that a kiln of brick cannot be burnt, or a batch of pottery made, but some of the brick or ware will be at least superficially turned to glass ; so that it must have been known at the building of Babel, and likewise by the Egyptians, among whom the Israelites were many years employed in making bricks. Of this kind, no doubt, was that fossil glass, mentioned by Ferrant, Imperat. to be found under ground in many places, where there great fires had been.

A writer of eminence, makes a distinction between glass contained in its own mine or stone, and true glass that is extracted from the same ; that the latter is more artificial than a metal is, when extracted from the ore ; and as to the former, he urges, that as metal, by having its existence in the ore, so glass, by having it in the stone out of which it is produced, is a natural production. After what has been advanced, the supposition arises, if glass is procured from stone alone, the weight of the metal must be less than the substance from which it is extracted, whereas it far exceeds, as 100 pounds of sand yield 150 pounds of glass. Considering also, that the salts made use of are of the most fixed kind, therefore we cannot suppose them to be carried off by the fire ; besides, as a proof, in the coarser glasses one may discern, or even pick out pieces of salt, furnishing a test by the taste. Flint, sand and stone afford different species of glass, and the ashes, as they are variable in quality, will proportionately alter the glass. A fixed alkaline salt, sharp and well purified, mixed with a pure calx of flint, yields a glass clearer than amber itself. Our representation of the manufacture of glass, no doubt, is imperfect, though we are flattered it may not be wholly uninteresting.

*Grecian Gilding.* Equal parts of sal ammoniac and corrosive sublimate are dissolved in spirit of nitre, and a solution of gold made with this menstruum. The silver is brushed over with it, which is turned black, but on exposure to a red heat, it assumes the colour of gold.

*Gilding Metal.* Four parts copper, one part Bristol old brass, and four oz. of tin, to every pound of copper.

*To dissolve Gold in Aqua-Regia.* Take an aqua-regia, composed of two parts of nitrous acid, and one of marine acid, or of one part of sal ammoniac and four parts of aqua-fortis ; let the gold be granulated, put into a sufficient quantity of

this menstruum, and expose to a moderate degree of heat. During the solution an effervescence takes place, and it acquires a beautiful yellow colour, which becomes more and more intense, till it has a golden or even orange colour. When the menstruum is saturated, it is very clear and transparent.

*To gild Iron or Steel with a solution of Gold.* Make a solution of eight ounces of nitre and common salt, with five ounces crude alum, in a sufficient quantity of water; dissolve half an ounce of gold, thinly plated and cut; and afterwards evaporate the dryness, digest the residuum in rectified spirit of wine or ether, which will perfectly abstract the gold. The iron is brushed over with this solution, and becomes immediately gilt.

2. Pour into a saturated solution of muriate of gold (that is, when there is no excess of acid) about twice as much sulphuric ether: now brush upon a clear polished surface of iron or steel some of this liquid. The ether will soon evaporate, and leave the gold covering the surface. To gild silver or copper, heat gold and mercury together in a crucible, one part of gold to about eight of mercury, until they are completely alloyed: then throw the hot alloy into cold water. Having wet the silver or copper with diluted nitric acid, brush on the alloy with a fine brush (a wire brush is best) as uniformly as possible. Then drive off the mercury with heat, placing the gilded metal over the hot coals: afterwards the surface must be polished with a burnisher. The only objection made to this method by artists is, that it is very difficult to lay on the alloy evenly. But old artists learn to brush over the bare spots while it is heating, being careful to avoid inhaling the mercurial fumes.

This method of gilding iron is undoubtedly very perfect; but it is desirable some better method should be discovered for gilding the other metals.

*To coat Copper with Silver.* Take a few grains of silver in powder as precipitated by copper in a preceding experiment, after it is washed and before melting; about an equal weight of alum or a little more; six times as much table salt; also six times as much tartrate of potash; pulverize all these articles and rub them well together; rub the clean bright surface of a piece of copper with this powder, and it will be silvered.



This silvering is not very durable, though it may be easily renewed. Plating copper is much preferable. This is done by brazing on a thin bar of silver upon a thick bar of copper. Then both are rolled out into the proper thickness for use.

*To gild by dissolving Gold in Aqua-Regia.* Fine linen rags are soaked in a saturated solution of gold in aqua-regia, gently dried, and afterwards burnt to tinder. The substance to be gilt must be well polished; a piece of cork is first dipped into a solution of common salt in water, and afterwards into the tinder, which is well rubbed on the surface of the metal to be gilt, and the gold appears in all its metallic lustre.

*To gild Ivory, Silk, &c. with Hydrogen Gas.* Immerse a piece of white silk or ivory into a solution of nitro-muriate of gold, in the proportion of one part of the acid, three of distilled water; whilst the substance to be gilded is still wet, immerse it in a jar of hydrogen gas; it will soon be covered by a complete coat of gold. The foregoing experiment may be advantageously varied as follows: Paint flowers or other ornaments with a very fine camel's hair pencil, dipped in the above mentioned solution, on pieces of silk, satin, &c. hold them over a Florence flask, from which hydrogen gas is evolved, during the composition of the water by sulphuric acid and iron filings. The painted flowers, in a few minutes, will shine in all the splendour of the purest gold, which will not tarnish on exposure to the air or in washing.

*Oil gilding on Wood.* Cover and prime the wood with two or three coatings of boiled linseed oil and carbonate of lead, in order to fill up the pores, and conceal the irregularities of the surface occasioned by the veins in the wood. When dry, lay on a thin coat of gold size, which is prepared by grinding some of the red oxide of lead with the thickest drying oil procurable, and mixed previously to using with a little oil of turpentine, till brought to a proper consistence. If the gold size is good, it will dry in twelve hours, more or less. Then spread a leaf of gold on a cushion, formed by a few folds of flannel, secured on a piece of wood, eight inches square, by a tight covering of leather, and cut into strips of a proper size by a blunt pallet knife; then take each strip upon the point of a fine brush, and apply it to the part intended to be gilded, which gently press down with a ball of soft cotton; in a few minutes sweep away the loose particles with

a large camel's hair brush. In a day or two the size will be completely dried, and the operation finished.

*To gild by Burnishing.* This operation is chiefly performed on picture frames, mouldings, &c. Cover the surface to be gilt corefully with a strong size, made by boiling down pieces of white leather, or clippings of parchment, till they become a stiff jelly; this coating being dry, eight or ten more must be applied, consisting of the same size, mixed with fine plaster of Paris, or washed chalk. When a sufficient number of layers are put on, as the nature of the work requires, and become quite dry, apply a moderately thick layer, composed of size and armenia bole or yellow oxide of lead. While this last is yet moist, put on the gold leaf in the usual manner; pressing it with the cotton ball; and before the size is become perfectly dry, the parts intended to be most brilliant, should be carefully burnished by an agate or dog's tooth fixed in a handle.

It is sometimes common, in order to save labour, but a bad practice, slightly to burnish the bailliant parts, and to deaden the rest, by drawing a brush over them dipped in size. This kind of gilding can only be applied on in-doorwork, as rain, or even a considerable degree of dampness will occasion the gold to peel off. When dirty, it may be cleansed by a soft brush, with hot spirit of wine, or oil of turpentine.

*To Dye in Gold, Silver Medals through.* Take some salt petre, pour over it a sufficient quantity of oil of vitriol, to swim over. When the ebullitions arising from that mixture shall be ended, distil to dryness—there remains a white salt. Dissolve in what quantity of warm water you think proper, or may be in need of, which you know when you see the water can dissolve no more of it—put into this a drachm of calx or magister of gold. Then put in digestion, in it, laminas cut small and thin, for twenty-four hours, over a very gentle fire. At the end of that time, you will find them thoroughly dyed gold colour, inside and out.

*Silvering Powder.* Silver dust from fifteen to twenty grains, cream tartar, common salt, each two drachms, alum half a drachm.

2. Silver dust, half an ounce, common salt, sal ammoniac, of each two ounces, corrosive sublimate, one drachm; make into a paste with water, used to silver copper, which is to be cleaned by boiling with argol and alum, then rub it with either of these powders, and polish with soft leather.

*To gild Copper, &c. by Amalgamation.* Immerse a very clean bright piece of copper in a diluted solution of nitrate of mercury. By the affinity of copper for the nitric acid, the mercury will be precipitated; now spread the amalgam of gold rather thinly over the coat of copper just given to the mercury. This coat unites with the amalgam, but will remain on the copper. Now place the piece thus operated upon, in a clean oven or furnace, where there is no smoke. If the heat is a little greater than 600 deg. the mercury of the amalgam will be volatilized, and the copper will be beautifully gilt.

In the large way of gilding, the furnaces are so constructed, that the volatilized mercury is again condensed, and preserved for further use, so that there is no loss in the operation. There is also a contrivance by which the volatile particles of mercury are prevented from injuring the gilders.

*To Gild Steel.* Pour some of the ethereal solution of gold into a wine glass, and slip therein the blade of a new penknife, lancet or razor; withdraw the instrument and allow the ether to evaporate. The blade will be found to be covered with a very thin coat of gold. A clean rag, or a small piece of very dry sponge may be dipped in the ether, and used to moisten the blade, and used with the same result. In this case there is no occasion to pour the liquid into a glass, which would lose by evaporation; but the rag or sponge may moistened with it by applying either to the mouth of the phial. This coating of gold will remain in the steel for a great length of time, and will preserve it from rusting. This is the way in which swords and other cutlery are ornamented. Lancets too are in this way gilded with great advantage, to secure them from rust.

*To heighten the color of Yellow Gold.* Six ounces saltpetre, two ounces copperas, one ounce white vitriol and one ounce alum. If it be wanted redder, a small portion of blue vitriol must be added. These are to be well mixed and dissolved in water as the colour is wanted.

*To heighten the colour of Green Gold.* One ounce ten pennyweights saltpetre, one oz. four pennyweights sal ammoniac, one oz. four pennyweights Roman vitriol, and eighteen pennyweights verdigris. Mix them well together, and dissolve a portion in water, as occasion requires. The work must then be dipped in these compositions, applied to a pro-

per heat to burn them off, and then quenched in water or vinegar.

*To heighten the colour of Red Gold.* Four oz. yellow melted wax; add 1 1-2 oz. red ochre, in fine powder, 1 1-2 oz. verdigris, calcined till it yields no fumes, and half an oz. calcined borax. It is necessary to calcine the verdigris, or else, by the heat applied in burning the wax, the vinegar becomes so concentrated as to corrode the surfaces and make it appear speckled.

*To separate Gold from gilt Copper or Silver.* Apply a solution of borax, in water, to the gilt surface with a fine brush, and sprinkle over it some fine powdered sulphur. Make the piece red hot, and quench it in water. The gold may be easily wiped off with a scratch brush, and recovered by testing it with lead. Gold is taken from the surface of the silver, by spreading it over a paste, made of powdered sal ammoniac, with aqua-fortis, and heating it till the matter smokes, and is nearly dry, when the gold may be separated by rubbing it with a scratch brush.

*To Silver with Heat.* Dissolve an ounce of pure silver in aqua-fortis, and precipitate it with common salt; to which add one pound of sal ammoniac, sandiver, and white vitriol, and one ounce of sublimate. 2. Dissolve an ounce of pure silver in aqua-fortis, precipitate it with common salt, and add after washing, six oz. common salt, three oz. each of sandiver and white vitriol, and one fourth of an ounce of sublimate. These are to be ground into a paste upon a fine stone with a muller; the substance to be silvered must be rubbed over with a sufficient quantity of the paste, and exposed to a proper degree of heat. When the silver runs, it is taken from the fire, and dipped into a weak spirit of salt to clean it.

*Silvering on Gilt work by Amalgamation.* Silver will not attach itself to any metal by amalgamation, unless it be first gilt; the process is the same as gilding in colours, only no acid should be used.

*To Silver in the Cold Way.* Two drachms tartar, two drachms common salt, one-half drachm alum and 20 grains silver, precipitated from the nitrous acid by copper. Make them into a paste with a little water. This is to be rubbed on the surface to be silvered with a cork, &c. 2. Dissolve pure silver in aqua-fortis, and precipitate the silver with common salt; make this precipitate into a paste, by adding a little more salt and cream of tartar,

*To Silver Copper Ingots.* The surface of the copper on which the silver is to be fixed must be made flat by foiling, and should be left rough. The silver is first annealed, and afterwards pickled in weak spirit of salt; it is planished, and then scraped on the surface to be fitted on the copper. These prepared surfaces are anointed with a solution of borax, or strewed with fine powdered borax itself, and then confined in contact with each other, by binding wire. When they are exposed to a sufficient degree of heat, the flux causes the surfaces to fuse at the same time, and after they become cold, they are found finely united. Copper may likewise be plated by heating it, and burnishing leaf silver upon it; so may iron and brass.

The principal difficulties in plating copper are to bring the surfaces of the copper and silver into fusion at the same time, and to prevent the copper from scaling; for which purpose fluxes are used.

*To separate Silver from Plated Copper.* This process is applied to recover the silver from the plated metal, which has been rolled down for buttons, toys, &c. without destroying any large proportion of the copper. For this purpose a menstruum is composed of three pounds oil vitriol, one and a half ounces nitre, and a pound of water. The plated metal is boiled in it, till the silver is dissolved, and then the silver is dissolved, and then the silver is recovered by throwing common salt into the solution.

*Amalgam of Gold in the large way.* A quantity of quicksilver is put into a crucible or iron ladle which is lined with clay, and exposed to heat till it begins to smoke. The gold to be mixed should be previously granulated, and heated red hot, when it should be added to the quicksilver, and stirred about with an iron rod, till it is perfectly dissolved. If there should be any superfluous mercury, it may be separated by passing it through clean soft leather, and the remaining amalgam will have the consistence of butter, and contain about three parts of mercury to one of gold.

*To gild by Amalgamation.* The metal to be gilt is to be previously cleansed on its surface, by boiling in a weak pickle, which is a very dilute nitrous acid. A quantity of aqua-fortis is poured into an earthen vessel, and quicksilver put therein, when a sufficient quantity of mercury is dissolved, the articles to be gilt are put into the solution, and stirred about with a brush till they become white. This is called quickening; but

as during quicken by this mode, a noxious vapour continually arises, which proves very injurious to the health of the workmen, they have adopted another method, by which they in a great measure, avoid that danger. They now dissolve the quicksilver in a bottle containing aqua-fortis, and leave it in the open air during the solution, so that the noxious vapours escape into the air. Then a little of this solution is poured into a basin, and with a brush dipped therein, they stroke over the surface of the metal to be gilt, which immediately becomes quickened. The amalgam is now applied by one of the following methods:

1. By proportioning it to the quantity of articles to be gilt, and putting them into a white heat together, working them about with a soft brush, till the amalgam is uniformly spread. Or, 2. By applying a portion of the amalgam upon one part, and spreading it on the surface, if flat, by working it about with a harder brush. The work thus managed is put into a pan, and exposed to a gentle degree of heat; when it becomes hot, it is frequently put into a heat and worked about with a painter's large brush, to prevent an irregular dissipation of the mercury, till, at last, the quicksilver is entirely dissipated, by a repetition of heat, and the gold is attached to the surface of the metal. This gilt surface is well cleansed by a wire drush, and the artists heighten the colour of the gold by the application of various compositions; this part of the process is called colouring.

*To Gild Glass and Procelain.* Drinking and other glasses are sometimes gilt on their edges. This is done, either by an adhesive varnish, or by heat. The varnish is prepared by dissolving in boiled linseed oil an equal weight, either of copal or amber. This is to be diluted by a proper quantity of oil of turpentine, so as to be applied as thin as possible to the part of the glass, intended to be gilt. When this is done which will be in about twenty-four hours, the glass must be placed in a stove, till so warm as almost to burn the fingers when handled. At this temperature the varnish will become adhesive, and a piece of leaf gold applied in the usual way, will immediately stick. Sweep off the superfluous portions of the leaf, and when quite cold it may be burnished, taking care to interpose a piece of very thin paper, between the gold and burnisher. If the varnish is very good, this is the best method of gilding glass, as the gold is thus fixed on more evenly.

It often happens that the varnish is but indifferent, and that by repeated washing the gold wears off: on this account the practice of burning it, is sometimes had recourse to. For this purpose, some gold powder is ground with borax, and applied to clean glass, by a camel's hair pencil; when quite dry, the glass is put into a stove heated to about the temperature of an annealing oven: the gum burns off, and the borax, by vitrifying, cements the gold with great firmness to the glass; when it may be burnished. Porcelain and other wares may be platinized, silvered, tinned, and bronzed, in a similar manner.

*To Gild Leather.* Dust the leather over with very fine powdered yellow resin or mastic gum. The iron tools should be arranged (if letters alphabetically) on a rack before a clear fire; to be well heated without becoming red hot. Each letter or stamp must be tried as to its heat, on the raw side of a piece of waste leather. Now, press the tool downward on the leaf, if it has acquired a proper heat; which will become indented and show the figure imprinted on it—the next letter is taken and stamped in like manner; and so on with the others: the superfluous gold may be rubbed off by a cloth. The cloth should be slightly greased, to retain the gold wiped off. The cloth will soon become saturated with gold, and is generally sold to refiners to recover the gold. Some afford as much gold by burning as to be worth a guinea and a half.

*Gold powder for Gilding.* Gold powder may be prepared in three different ways: 1. Put into an earthen mortar some gold leaf, with a little honey, or thick gum water, and grind the mixture till the gold is reduced to extremely minute particles. When this is done, a little warm water will wash out the honey or gum leaving the gold behind in a pulverulent state.

2. Dissolve pure gold, (or the leaf,) in nitro-muriatic acid, and then precipitate it by a piece of copper, or by a solution of sulphate of iron. The precipitate, (if by copper,) must be digested in distilled vinegar, and then washed, (by pouring water over it repeatedly,) and dried. This precipitate will be in the form of a very fine powder; it works better, and is more easily burnished than gold leaf ground with honey as above.

3. Or the best method is, by heating a prepared amalgam

of gold, in an open clean crucible, and continuing the strong heat until the whole of the mercury is evaporated; at the same time constantly stirring the amalgam with a glass rod. When the mercury has completely left the gold, the remaining powder is to be ground in a wedgewood mortar, with a little water, and afterwards dried. It is then fit for use. Although the last mode of operating has been here given, the operator cannot be too much reminded of the danger attending the sublimation of mercury. In the small way here described it is impossible to operate without danger; it is therefore better to prepare it according to the former directions, than to risk the health by the latter.

*To Gild Writings, Drawings, &c.* Letters written on vellum or paper are gilded in three ways; for the first, mix size with the ink, and the letters are written as usual; when dry a slight degree of stickiness is produced, by breathing on them; then apply the gold leaf, making a little pressure, that it may adhere with firmness. The second method is, some white lead or chalk is ground up with strong size, and the letters are made by this means with a brush; when dry, the gold leaf may be laid on, and afterwards burnished. The last process is to mix up some gold powder with size, and to form the letters by means of a brush. It is supposed this last method was used by the monks in illuminating their missals, psalters, and rubrics.

*To Gild on the Edges of Paper.* Leaves of books and letter paper should be gilded while in a horizontal position in the book binder's press. Apply a composition formed of four parts of Armenian bole, and one of candied sugar, ground to a proper consistence in water, and laid on by a brush with the white of an egg. When nearly dry, smooth the coating by a burnisher; which is generally a crooked piece of agate, very smooth, and fixed in a handle. Then slightly moisten it by a sponge dipped in clean water, and squeezed in the hand. Take up the leaf on a piece of cotton, from the leather cushion, and apply it to the moistened surface. When dry, burnish it by rubbing over it the agate repeatedly from end to end, taking care not to wound the surface by the point of the burnisher. A piece of silk or India paper is usually interposed between the gold and burnisher.

*To Gild in Colours.* The principal colours of gold for gilding are red, green, and yellow. These should be kept in



different amalgams. The part which is to remain of the first colour is to be stopped off with a composition of chalk and glue; the variety required is produced by gilding the unstopped parts with the proper amalgam, according to the usual mode of gilding. Sometimes the amalgam is applied to the surface to be gilt without any quicking, by spreading it with aqua-fortis; but this depends on the same principle as a previous quicking.

*To Plate Looking-glasses.* On tin foil fitly disposed on a flat table, mercury is to be rubbed with a hare's-foot; it soon unites itself with the tin. A plate of glass is then cautiously to be slid upon the tin leaf, in such a manner as to sweep off the redundant mercury, not incorporated with the tin. Lead weights are then placed on the glass, and in a little time, the quicksilver tin foil, adheres so firmly to the glass, that the weights may be removed without danger of its falling off. About two ounces of mercury is sufficient for covering three square feet of glass. The glass should be perfectly clean: the least dirt or dust on the surface will prevent the adhesion of the amalgam.

Put a drop of mercury into a wine glass, and drop into it small pieces of tin foil, which will become liquified and unite with the mercury. Continue these additions until the amalgam contains about half as much tin as mercury. Next spread a small piece of tin foil very evenly on the face of a smoothing iron or a piece of polished marble; pour the amalgam upon it and rub it over the tin foil with the finger for about two minutes. Now press upon it a piece of dry clean glass; press it down with such force as to press out all the uncombined mercury; lay a weight upon the glass and leave it half an hour, when it may be taken up, and it will be found to be a mirror.

All looking glasses are made in this way, upon a large scale; the slab is placed in an inclined position, so that the excess of mercury runs, and is saved for the next, &c.

*To silver Glass Globes.* One ounce clean lead, one ounce fine tin, one ounce bismuth, and ten ounces of quicksilver. Put the tin and lead into the ladle first; when melted, add the bismuth. Skim off the dross, remove the ladle from the fire, and before it sets, add the quicksilver; stir the whole carefully together, taking care not to breathe over it as the fumes of the mercury are very pernicious. Pour this through an

earthen pipe, into the glass globe, which turn repeatedly round. 2. Two parts mercury, one part tin, one part lead, and one part bismuth; or four ounces of quicksilver and tin foil. The quantity of tin foil to be added, is so much as will become barely fluid when mixed. Let the globe be clean and warm, and inject the quicksilver by means of a pipe at the aperture, turning it about till it is silvered all over. Let the remainder run out, and hang the globe up.

*A Gold coloured Ink.* Pulverize very fine one ounce of orpiment, and as much crystal; put this powder in five or six whites of eggs, well beaten, then turned into water. Mix all well, and it will be prepared to write or paint, producing a gold colour.

*A Silver coloured Ink.* Finest of pewter, one ounce, quicksilver, two ounces. They should be mixed until quite fluid. Then grind it on porphyry with some gum water, when it is fit to use. The writing will appear as if it had been done with silver.

*To prepare the Silver Tree.* Pour into a glass globe or decanter, four drachms nitrate of silver, dissolved in a pound or more of distilled water, and lay the vessel on the chimney piece; or where it may not be disturbed. Now pour in four drachms of mercury. The silver will become precipitated in the most beautiful arborescent form; resembling real vegetation.

*To prepare the Tin Tree.* Into a vessel similar to that used in the last experiment, with the same quantity of water put in three drachms of muriate of tin, adding ten drops nitric acid. Shake the vessel until the salt be completely dissolved. Replace the zinc (which must be cleared of the effects of the former experiment,) as before, and set the whole aside to precipitate without disturbance. In a few hours the effects will be similar to the last, only that the tree will have more lustre. In these experiments it is surprising to observe the laminae shoot out as it were from nothing; but this phenomenon seems to proceed from a galvanic action of the metals and the water.

*To prepare the Lead Tree.* Put one half an ounce of the superacetate of lead in powder, into a clear glass globe or decanter, filled to the bottom of the neck, with distilled water, and ten drops nitric acid, and shake the mixture well. Prepare a rod of zinc with a hammer and file, a quarter of an

inch thick and one inch long. Form notches in each side for a thread, by which it is to be suspended; tie the thread so that the knot may be uppermost, when the metal hangs quite perpendicular. When tied, pass the two ends of the thread through a perforation in the cork and let them be again tied over a small splinter of wood, which may pass between them and the cork. When the string is tied, let the length between the cork and zinc be such that the zinc may be at equal distances from the side, bottom and top of the vessel when immersed in it. Now put the vessel in a place where it may be undisturbed; introduce the zinc, at the same time fitting in the cork. The zinc will assume the form of a tree or bush, whose leaves and branches are laminal, or plates of a metallic lustre.

*Glazing the Clay Cake.* Lay a sun dried plastic or refractory clay cake obliquely across a crucible of such a length as to go entirely into the crucible, but not let it reach the bottom. Heat the crucible until the clay cake is at a white heat, then throw a little common salt, (muriate of soda) into the crucible and continue to raise the heat. On taking out the clay cake, its surface will be found covered with a glazing, made of the soda and alumine fused together. Dip a dried cake into mortar, sufficiently diluted with water to become a free liquid, which is made of marled clay. Then heat it as before, and it will become glazed. Upon this principle potter bakers glaze their wares.

*To prepare Copper Foils.* When coloured foils are wanted, copper may therefore be best used, and may be prepared for the purpose as follows. Take copper plates, beaten to a proper thickness, and pass them between a pair of fine steel rollers, very close set, and draw them as thin as is possible to retain a proper tenacity. Polish them with very fine whiting or rotten stone, till they shine, and have as much brightness as can be given them, and they will then be fit to receive the colour.

*To whiten Foils.* When the yellow, or rather orange colour of the ground would be injurious to the effect, as in the case of purple or crimson red, the foils should be whitened, which may be done in the following manner.

Take a small quantity of silver and dissolve in *aqua-fortis*; then put bits of copper into the solution, and precipitate the silver; which being done, the fluid must be poured off, and

fresh water added to it, to wash away all the remainder of the first fluid ; after which the silver must be dried, and equal weight of cream of tartar and common salt must then be ground with it, till the whole is reduced to a fine powder ; and with this mixture the foils, being first slightly moistened, must be rubbed by the finger or a bit of linen rag, till they be of the degree of whiteness desired ; after which, if it appear to be wanting, the polish must be refreshed. Tin foils are only used in the case of colourless stones, when quicksilver is employed ; and they may be drawn out by the same rollers, but need not be further polished, so that the effect is produced by other means in this case.

*Foils for Crystals, Pebbles, or Paste, to give the lustre of Diamonds.* The manner of preparing foils to give colourless stones the greatest degree of play and lustre, is by raising so high a polish or smoothness on the surface, as to give them the effect of a mirror, which can only be done, in a perfect manner, by the use of quicksilver, applied in the same general way as in the case of looking-glasses. The method

is as follows: Take leaves of tin, prepared in the same manner as for silvering looking-glasses, and cut them into small pieces of such size as to cover the surface of the sockets of the stones that are to be set. Lay three of these, then, one upon another, and having moistened the inside of the socket with this gum water, and suffered it to become again so dry, that only a slight stickiness remains, put the three pieces of leaves, lying on each other, into it, and adapt them to the surface in as even a manner as possible. When this is done, heat the socket, and fill it with warm quicksilver, which must be suffered to continue in it three or four minutes and then gently poured out. Then thrust the stone into the socket, which must be closed with it, care having been taken to give such room for it, that it may enter without stripping off the tin and quicksilver from any part of the surface. The work should be well closed round the stone to prevent the tin and quicksilver contained in the socket from being shaken out by any violence.

The lustre of stones, set in this way, will continue longer, than when they are set in the common way, as the cavity, round them being filled, there will be no passage found for moisture, which is so injurious to the wear of stones treated in any other way. This kind of foil gives some lustre.

## CHAPTER XIX.

*Art of engraving—etching—directions—to make blue letters on Sword Blades—to detect false gems.*

Engraving is the art of cutting metals and precious stones, and representing on them whatever device the artist pleases, and that great numbers of an impression from the same engraving may be taken, in a short time, and at a small price.

The French divide the art into several branches, according to the different materials wrought upon, and the manner of execution.

Among us, the first method is distinguished, as cutting in wood; that on metals, with aqua-fortis, is named *etching*; that by the knife, burnisher, or scraper, *mezzotinto*; that on stones, carving, or stone cutting; and that performed with a graver on metals or precious stores, which we shall now attempt more immediately to illustrate. The principle on which this art is founded, are the same with those of painting, viz. *design*, which an engraver ought to make his peculiar study, for without that he will neither be able to imitate the performances of the greatest masters in painting, or design any thing beautiful of his own. In imitating the paintings of eminent masters, the engraver should studiously conform himself to the taste and beauty of the copy, in order to preserve that elegance of character which distinguishes the style of one master from another; and in doing which to any tolerable degree of perfection, it is necessary that an engraver should understand perspective, and architecture. The former enables him with ease to throw backwards, by the natural degradations of strong and faint, the figures and other objects of the picture, or design he would execute; the latter will capacitate him to preserve the due proportion of its order. To execute in this art, as well as every other, the materials which are used should be duly regarded. The best workmen prefer the red copper, which is the toughest. His plates should be well polished when he commences to trace any thing on them; his graver should be of the purest steel, well tempered and never blunt.

In conducting the strokes of the graver, care ought always to be taken that they flow freely and naturally. The graver should be conducted according to the various risings and cavi-

ties of the muscles, which in some measure depends upon a knowledge in anatomy, as well as design. In sculpture the work should never be made dark; as statues, &c. are commonly made of white marble, or stone, the colour reflecting on all sides, does not produce dark shades. In regard to drapery of every kind, if the diversity of stuffs can be represented, it generally adds to the beauty of the piece; when there is a necessity of crossing the strokes, it must be observed that the first should be finer than the second and the third than the second which makes the work appear more soft and mellow. Stuffs that have a lustre should be imitated by striking with stronger and straighter strokes than others; being generally silk, producing flat and broken folds, should be expressed by one or two strokes, as their colours vary, with finer ones between them. Velvet and plush are represented in the same manner, by fine strokes between others, with this difference; the first strokes should be much stronger than for stuffs, and the finer ones proportionate. Metals or vessels of gold and copper, or armour of polished steel, are to be engraved with fine strokes, between the strong ones, it being the opposition of light and shade, that occasions the lustre. With respect to architecture, perspective shows us the strokes which form receding objects tend to the point of view; when the piece is to contain entire columns, they are to be represented by perpendicular lines; for in crossing them according to their roundness, those strokes which are near their capitals, being opposed to those near their base, produce a disagreeable effect; unless supposed to be at a great distance, which renders the object near parallel.

For landscapes, the practicers of etching may form the outlines by it, particularly of the leaves of trees, which is more expeditious than engraving, and does as well. In this case, care should be taken in finishing it well with the graver, that the etching be imperceptible, because it has not the softness of engraving. In representing steep objects, the first strokes should be frequently interrupted and broken off, the second straight, cutting the others with acute angles, accompanied with long points. To represent rocks, the second strokes should not form the angles so acute as in representing other objects. Objects receding towards the horizon should be touched very lightly, and charged with little shade, though

the mass should appear dark, as from some shade supposed to proceed from the clouds intercepting the rays of the sun. Calms are represented by straight strokes, running parallel with the horizon, with finer ones between them, and are to be omitted in some places, to make their shining reflection which proceeds from the water. By the second strokes also, made more or less strong, and sometimes by perpendicular ones, the forms of objects, either reflected on the surface of the water, or advanced at a distance on its banks, are represented.

The waves of the sea, are represented by strokes, bending according to the agitation of the water, with finer ones between them, cutting them with very acute angles. To represent water falling with rapidity from rocks or precipices, must be expressed by first strokes according to the nature of their fall, with finer ones between them, leaving the lights formed by the beams of the sun, falling directly on them very bright, and the more so as they approach the fore part of the piece. When the clouds appear thick and agitated, the graver should be turned about according to their form and agitation; and if they produce dark shades, which require double strokes, the second should cut the first in more acute angles than in figures. Flat clouds, losing themselves insensibly with the sky, must be formed by strokes parallel with the horizon, waved a little, as they appear more or less thick. A calm serene sky should be expressed by parallel strokes very straight without any winding. Though all the parts of a piece of engraving may be executed according to the rules of art, yet, unless there be a general proportion and harmony diffused throughout it will not appear beautiful. The principal objects of a piece should be wholly sketched out before any part of them are finished. Engraving seems to be in one respect, the same in relation to printing, as painting is to hand writing; this art being capable of multiplying copies ad infinitum.

No art, perhaps, can have a happier or more influential tendency to the advancement of virtue, religion and industry; nothing has a more familiar efficacy to form an universal good taste than prints, though it may be prostituted to the vilest, most debauched and detestable purposes. When this admirable art is thus abused, we see no reason why the authors should not be as liable to punishment by the laws, as others,

who are the promoters and perpetrators of vice and immorality.

As this art is applicable to most others, so, to arrive at any excellence in it, requires a knowledge in various other arts, as geometry, perspective, anatomy, drawing, painting, sculpture, and above all things, *designing*. What is ordinarily called genius, is certainly an innate discernment, and a strong impulse and propensity to excel in any peculiar art; without which, nature seems to be unnaturally constrained; and when that is the case, the performances of such persons will also appear forced, uncouth, and unnatural also, like the disposition of the performer; for as some poet says,—

No art without a genius can prevail,  
And parts without the help of art will fail.

When Marius, being driven from Rome by Sylla, and was a prisoner at Minturnæ, a soldier was sent to murder him. Upon his coming into the room with his sword drawn for the purpose, Marius said aloud, “durst thou, man, kill Caius Marius?” which so terrified the ruffian that he retired without effecting his purpose. “This story, or one glance of the eye upon his statue that I have seen,” says an English writer, “gives me a greater idea of him than all Plutarch has wrote.” And further remarks, “the Odyssey cannot give a greater idea of Ulysses, than a drawing I have of Polydore, when he is discovering himself to Penelope and Telemachus, by bending the bow. And I conceive as highly of St. Paul, by once walking through the gallery of Raphael at Hampton Court, as by reading the whole book of the Acts of the Apostles, though written by divine inspiration. Finally, in regard to history, nothing can be more useful than an attempt to excel in this art, in order to fix in remembrance memorable events. And as it is considered to be but in its infancy, it is to be greatly desired, that every meritorious performance, made in this country, will meet with public encouragement, not only for the honour of the nation, and rising artists, but for the benefit of traffic; so that, instead of importing immense quantities of foreign prints, we may not only supply ourselves, but become exporters of a commodity that is universally vendible.

*Floric Acid, with which etchings of any device, name or stanza, &c. on glass, common flint, cornelian, &c. can be performed.* Put into the etching box a tea spoonful of



coarsely pulverized flour-spar, and set the box into a pan of coals, placed on bricks upon a table; pour in strong sulphuric acid, sufficiently to moisten or moderately wet it; the acid will immediately rise up out of the cup, which may be known by its attracting so much vapour from the air as to exhibit the appearance of common steam. As soon as it begins to appear, which will be in a few seconds, lay over the cup a piece of common window glass, large enough to cover its mouth, which had been previously waxed and written upon; let an assistant immediately apply snow, ice, or cold water to the upper side of the glass, in order to keep it so cool as to prevent the wax which is on the under side from melting; take off the glass in ten seconds, and apply another and so on; two or three may be applied before the flour-spar and sulphuric acid are renewed. The writing made in wax will appear beautifully etched upon the glass, on scraping off the wax. The best method of preparing the glass is to warm, or rather heat moderately, the face of a smoothing iron or piece of polished marble; so that white wax or very fine beeswax will melt on being applied to it. Lay the glass flint upon the melted wax, and on sliding it off it will be very evenly waxed; a dozen pieces may be prepared in succession; the writing may be made with the end of a hard stick, &c. Care must be taken to lay the glass perfectly bare through all the strokes, or there will be interruptions in the etching.

*A Wax to lay on Iron and Steel.* Take the bulk of a nut of white wax, melt it, and add the size of a musket ball of ceruse of Venice. When both are incorporated, form this composition into small sticks. With them rub your piece of iron or steel, after having previously warmed it sufficiently to melt the wax, which spread well over it with a feather. When the wax is cold, trace whatever you will on it, and pass afterwards on the lines you have drawn, the following water.

*A Mordant Water to engrave on Steel.* Take the strongest verjuice you can find; alum in powder, and a little dried salt, pulverized: mix until perfectly dissolved; then pass some of that water on the lines of your drawing, repeating the same till it is engraved. Or else take verdigris, strong vinegar, ammoniac and common salts, and copperas, equal parts. Set the compound a boiling for a quarter of an hour; then strain it through a rag, and run some of that water on your plate. In about half an hour afterwards it will be perfectly engraved.

See Collect's varnish, which is an admirable composition to lay on the plate you propose to engrave.

*To engrave with aqua-fortis, so that the work may appear like basso relievo.* Take equal parts of vermilion and black lead, two or three grains of mastic in drops; mix and grind them on marble; with linseed oil: then put the composition into a shell: then cut some soft quills, and let your steel or iron be well polished; try first whether your colour runs sufficiently with your pens; and if it should not, you must add a little more oil to it, so as to have your pen mark freely; as if you intended writing with ink on paper: then rub well your plate of steel with wood ashes; to clean it; after which wipe it with a clean rag, and draw your design upon it with your pen, prepared as before. If you wish to draw birds or other animals, you must only draw the outlines of them with your pen, then fill up the inside of those lines with a hair pencil; that is, you must cover all the space contained between the first outlines drawn with the pen, the same colour, which you must lay with a brush to preserve all that part against the mordacity of the aqua-fortis. When that is done, let your work dry for a day or two; and when dried, take some fire made with charcoal into a chafing dish, and bakn over it your colour by degrees; till it becomes quite brown. Take care notwithstanding, not to burn it; for fear you should seale it, when you come to scratch; with the point of a needle; those etchings or places which you wish to engrave with the aqua-fortis.

*Aqua-Fortis for Engraving.* Take verdigris, alum, rom. vitriol, and common salt, each, three ounces; pounded finely; put little more than a quart of water into a new pipkin, and the articles mentioned; infuse two hours; then place them over a charcoal fire, and when the water has in some degree evaporated, take the pipkin from the fire, let it cool so as to bear your hand without scalding. Then take an earthen cup, and pour over the work intended to be engraven, the liquid; and continue to do so for nearly three quarters of an hour. Then pour on it clean water, to wash off every impurity. Try the depth of the lines of your engraving with a needle; and if not sufficiently prepared, the process of wetting it with the mixture, must be again repeated; care should be taken, that the liquid is not too warm, as it will spoil the work.

*To engrave on Brass or Copper with Aqua-Fortis.* Add

more mastic in drops to your colour, and bake the plate until it becomes nearly black; if a flat work, raise round it a border of wax, to prevent the aqua-fortis from running off, which is to be a separating aqua-fortis, with which, cover the plate to the thickness of a crown; after it has been thus covered for a little while, it becomes green; then throw it away, and pour in its place some clear water, now examine the lines; if not of sufficient depth, put on some more aqua-fortis.

*To engrave prints by Aqua-Fortis.* Grind some ceruse with clear water; size with isinglass. Lay this on the plate with a coarse brush, or pencil. When dry, draw on it your design. Or, if you wish to counterproof a copperplate print, blacken the back of the print, and place that part on the plate, prepared as before; go over all the strokes of the print, with a smooth ivory or wooden point, which stamps the back of the print, in all those places, on the plate; then go over the black strokes on the plate, with a pen and ink; afterwards take a steel point, very fine and well tempered, etch the plate with it, in following all the strokes marked on it, and pour aqua-fortis as heretofore directed.

*Directions to be observed in engraving with Aqua-Fortis.* The plate must be well polished and perfectly clean; warm it over a chafing dish, in which there is a charcoal fire. While over the fire, cover it with varnish; then blacken it with the smoke of a candle; then chalk your design. The artists generally prefer drawing the outlines of their work, that the spirit and beauty of the design may be preserved. And for this purpose aqua-fortis is often employed to sketch lightly the outlines of the figures, and to have them more correct. It is necessary to touch a little occasionally with the graver, certain parts where the aqua-fortis has not eaten in sufficiently. In putting the aqua-fortis on the plate, care should be taken, that it does not eat too much: to prevent which, oil and tallow mixed, must be dropped on the work from the blaze of a candle. The artist should have a framed wooden board, overlaid with wax, on which the plate should be fixed a little slanting, that the aqua-fortis may pass over, and run into a pan placed there to receive it.

Thus covering at several times, and as much as is necessary, such places of the plate, as should not be kept so strong as others, rendering the figures which are forward in the pic-

ture, constantly every time, washed with the aqua-fortis which eats in them, till they are sufficiently engraved, and according to the strength which is necessary to give them.

To engrave on wood, prepare a board, of the size and thickness wanted, and polish it on the side to be engraved. Pear tree or box-wood is generally preferred. Draw first your design, as you wish to have it appear after printing. Care should be taken, that all the strokes of the drawing should touch well, and stick on the wood; and when the paper is very dry, (which is pasted on the board, by its right side, with a paste made of good flour, water, and a little vinegar, in case there is wanting a talent of drawing extemporaneously,) wet it gently, and with the top of your finger, rub it off by degrees, leaving only the strokes of the drawing on the board, as if it had been drawn with pen and ink. These strokes or lines show all that are to be spared or preserved; the rest should be cut off, and sunk down with delicacy, by means of a sharp and well pointed penknife, small chisel, &c. according to the size and delicacy of the work.

*To engrave on Copper with the graver.* The plate should be red copper, well polished; then draw your design on it with either the black lead stone, or a steel point. When that is done, you must be furnished with a sharp and well tempered graver to cut, in order to give more or less strength to certain parts, (as has heretofore been observed,) according to the subject; a tool of six inches in length is necessary, one end of which, is called a *scraper*, is made in the form of a triangle, sharp on each edge, for the purpose of scraping on the copper, when necessary; the other end is called a *burnisher*, nearly the shape of a fowl's heart, a little prolonged by the point, round and slender. This serves to polish the copper, to mend the faults, and soften the strokes. In order to form a better judgment of your work, you must occasionally, make use of a stump, made with the piece of an old hat rolled up and blackened, to rub the plate, which fills the strokes with black, and which enables you to discover imperfections. A leather cushion is also necessary to be provided with, to lay the plate on while engraving.

Etching may be performed by dipping a clean copper cent into melted white wax. On taking it out, the wax will immediately harden upon it. Mark out the form of a letter or figure upon it. Then immerse the cent in nitric acid, and let it remain fifteen minutes. Now

take it out, scrape off the wax, and wash the whole clean, and the letter will be etched upon the cent.

On this principle the etching upon razors, sword blades, &c. is performed. Artists have various methods for preparing compositions for applying to the metals before the acid is applied; they generally make use of something for writing the letters, which will flow from the pen like ink. Then they surround the whole space to be acted upon, by an edging to confine the acid, and pour on the acid, instead of immersing the metal in it, as is more particularly described in this chapter. This is called etching in basso-relievo.

*To make Blue Letters on Sword Blades.* Take a well polished sword blade and hold it over a charcoal fire, till it is blue, then with oil colour, write such letters, (or make such figures) as you wish should appear and remain, and let them dry; then warm some strong vinegar, and pour all over the blade, which will infallibly take off the blue colour. After this process, a little common warm water will take off the oil colour, and the letters or figures will appear and remain of a curious and indelible blue; the same may be done on any polished steel.

## CHAPTER XX.

*Sculpture—the process of casting in Plaster—Composition of Ancient Statues—Printing—Printers types.*

To ascertain when the art of sculpture was first practised and by what nation, is beyond human research; we may safely conjecture, however that it was one of the original propensities of man. This will still appear in the ardent and irresistible impulse of youth to make representations of objects in wood; and the attempts of savages to embody their conceptions of their idols; a command from the Author of our being, was necessary to prevent the ancient Israelites from making graven images: and the inhabitants of the rest of the earth possessed similar propensities. The descriptions in the Scriptures demonstrate that the art had been brought to great perfection at the period of which they treat. It is necessary to make a distinction between carving and sculpture; the former belongs exclusively to wood, and the latter to stone or marble. The acknowledged masters of this sublime art were the ancient Greeks. Such have been the excellence and correctness of their imitations of nature, and the refined elegance of their taste, that many of their works are mentioned, as efforts never to be exceeded or perhaps imita-

ted. Statuary is a branch of sculpture, employed in the making of statues. The term is also used for the artificer himself. Phidias was the greatest statuary among the ancients, and Michael Angelo, among the moderns. Statutes are not only formed with the chisel from marble, and carved in wood but they are cast in plaster of Paris, or other matters of the same nature, and in several metals, as lead, brass, silver, and gold.

*The process of Casting in Plaster of Paris.* Mix the plaster with water, and stir it until it attains a proper consistence; then pour on any figure, for instance, a human hand or foot, previously oiled in the slightest manner possible which prevents the adhesion of the plaster; in a few minutes the plaster will be dry to the hardness of soft stone, taking the exact impression of every part, even the minutest pores of the skin. This impression is called the mould. When taken from the figure that produced it, and slightly oiled, plaster mixed with water as before, may be poured into it, where it must remain until hardened; if it be then taken from the mould, it will be an exact image of the original figure. When the figure is flat, having no hollows, or high projections, it may be moulded in one piece, but when its surface is varied, it must be moulded in many pieces fitted together, and held in one or more outside or containing piece.

This useful art supplies the painter and sculptor with exact representations from nature, and multiplies models of all kinds. It is practiced in such perfection, that casts of the antique statutes are made so precisely like the originals in proportion, outline, and surface, that no difference is discoverable, excepting in colour, and materials.

*Composition of Ancient Statues.* According to Pliny, the metal used by the Romans, for their statues, and for the plates on which they engraved inscriptions, was composed in the following manner. They first melted a quantity of copper, into which they put one-third of its weight of old copper which had been long in use—to every hundred lbs. weight of this mixture, they added twelve and a half lbs. of alloy composed of equal parts of lead and tin.

*Metallic Casts from Engravings on Copper.* A most important discovery has lately been made, which promises to be of considerable utility in the fine arts; some beautiful specimens of metallic plates of a peculiar composition, have lately appeared—under the name of “cast engravings.” This

invention consists in taking moulds from every kind of engravings, with lime, mezzotinto, or aqua-tinta, and pouring on this mould an alloy, in a state of fusion, capable of taking the finest impression. The obvious utility of this invention, as applicable to engravings, which meet with a ready sale, and of which great numbers are required, will be incalculable, as it will wholly prevent the expense of retracing, which forms so prominent a charge in all works of an extended sale. No sooner is one cast worn out than another may be immediately procured from the original plate, so that every impression will be a proof. Thus the works of our most celebrated artists, may be handed down, *ad infinitum*, for the improvement and delight of future ages and will afford at the same time, the greatest satisfaction to every lover of the fine arts.

The art of Printing, deserves to be considered with attention and respect. From the ingenuity of its contrivance, it has ever excited mechanical curiosity; from its intimate connexion with learning, it has justly claimed historical notice; and from its extensive influence on morality, politics, and religion, is now become a very important speculation. Coining and taking impressions in wax, are of great antiquity, and the principle is precisely that of printing. The application of this principle to the multiplication of books, constituted the discovery of the art of printing. The Chinese have for many ages, printed with blocks, or whole pages engraved on wood. But the application of single letters or moveable types forms the merit of the European art. The honor of giving rise to this method has been claimed by the cities of Harlaem, Mentz, and Strasburg; and to each of these it may be ascribed in some degree, as printers resident in each, made successive improvements in the art. It is recorded by a reputable author, that Laurens Faustus, of Harlaem, walking in a wood near that city, cut some letters upon the rind of a beech tree, which for fancy's sake, being impressed upon paper he printed one or two lines for his grandchildren; and having thus succeeded, he invented a more glutinous ink because he found that the common ink sunk and spread; and then formed whole pages of wood, with letters cut upon them and, (as nothing is complete, in its first invention,) the back-sides of the pages were pasted together, that they might have the appearance of manuscripts, written on both sides of the

paper. These beechen letters, he afterwards exchanged for leaden ones, and these again for tin and lead, as a flexible, and more solid and durable substance. He died in 1440, and by some, his first attempt is supposed to have been made about 1430, but by others, as early as 1423.

From this period, printing has made a rapid progress in most of the principal towns of Europe, superceded the trade of copying, which, till that time, was very considerable, and was in many places considered as a species of magic. In 1490, it reached Constantinople, and was extended by the middle of the following century to Africa and America.

During the period since its invention, what has not the art of printing effected? It has blunted the edge of persecution's sword, laid open to man his own heart, struck the sceptre from the hand of tyranny, and awakened from its slumbers, a spirit of knowledge, cultivation and liberty. It has gone forth like an angel, scattering blessings in its path, solacing the wounded mind, and silently pointing out the triumphs of morality and the truths of revelation to the gaze of those, whom the want of precept or good example had debased, and whom ignorance had made sceptical.

The fourth centennial anniversary of the invention of printing, was observed at Harlaem in Holland, on the 10th and 11th July, 1823, with great rejoicing and a splendid festival.

*Printer's Types.* Ten pounds of lead, and two pounds of antimony. The antimony must be thrown into the crucible, when the lead is in a state of fusion. The antimony gives a hardness to the lead, without which, the type would speedily be rendered useless, in a printing press. Different proportions of lead; copper, brass and antimony, frequently constitute this metal. Every artist has his own proportions, so that the same composition cannot be obtained from different foundries; each boasts of the superiority of his own mixture.

*Small Types and Stereotype Plates.* Nine pounds of lead, and when melted, add two pounds of antimony, and one pound of bismuth.

This alloy expands as it cools, and is therefore, well suited for the formation of small printing types (particularly, when many are cast together, to form stereotype plates,) as the whole of the mould is accurately filled with alloy; consequently, there can be no blemish in the letters. 2. Eight



parts of lead, two parts of antimony, and one-third part of tin. For the manufacture of stereotype plates, plaster of Paris, of the consistence of a batter pudding before baking, is poured over the letter-press page and worked into the interstices of the types, with a brush. It is then collected from the sides, by a slip of iron or wood, so as to lie smooth and compact. In about two minutes, the whole mass, is hardened into a solid cake. This cake, which is to serve as the matrix of the stereotype plate, is now put upon a rack in an oven, where it undergoes great heat, so as to drive off the superfluous moisture. When ready for use, these moulds, according to their size, are placed in flat cast iron pots, and are covered over with another piece of cast iron, perforated at each end, to admit the metallic composition intended for the preparation of stereotype plates. The flat cast iron pots are now fastened in a crane, which carries them steadily to the metallic bath, or melting pot, where they are immersed, and kept for a considerable time, until all the pores and crevices of the mould are completely and accurately filled. When this has taken place, the pots are elevated from the bath, by working the crane, and are placed over a water trough, to cool gradually. When cold, the whole is turned out of the pots, and the plaster being separated, by hammering, and washing, the plates are ready for use, having received the most exact and perfect impression.

## CHAPTER XXI.

*Painting—historical—landscape or portrait—cartoon of Raphael—of Paul preaching at Athens—as applied to purposes of building—practical operations—distemper, or painting in water colours—in oil—colouring prints—mixing colours.*

THE art of painting gives the most direct and expressive representation of objects; and it was doubtless, for this reason employed by many nations, before the art of writing was invented, to communicate their thoughts, and to convey intelligence to distant places. The pencil may be said to write a universal language; for every one can instantly understand the meaning of a painter, provided he be faithful to the rules of his art. His skill enables him to display the various scenes of nature at one view; and by his delineation of the striking effects of passion, he instantaneously effects the soul of

spectator. Silent and uniform as is the address which a good picture makes to us, yet it penetrates so deeply into our affections, as to appear to exceed the power of eloquence. Painting is the most imitative of all the arts. It gives to us the very forms of those, whose works of genius and virtue, have commanded or won our admiration, and transmits them from age to age, as if not life merely, but immortality flowed in the colours of the artist's pencil; or to speak of its still happier use, it preserves to us the lineaments of those whom we love, when separated from us either by distance or the tomb. How many of the feelings, which we should most regret to lose, would be lost, but for this delightful art,—feelings that ennoble, by giving us the wish to imitate what was noble in the moral hero or sage, on whom we gaze, or that comfort us by the imaginary presence of those whose affection is the only thing dearer to us, than even our admiration of heroism or wisdom. The value of painting will, indeed, be best felt by those who have lost by death a parent or much loved friend; and who feel that they should not have lost every thing, if some pictured memorial had still remained.

Paintings, in regard to their subjects, are called historical, landscape or portrait; and in regard to the painters, they are divided into schools or countries; as the Italian, German, French, English, and other schools. Each of the schools has treated the practice of painting in its peculiar manner, and each with exquisite beauty and admirable effect. The great component parts of painting are, invention, or the power of conceiving the materials proper to be introduced into a picture; composition, or the power of arranging them; design, or the power of delineating them; the management of lights and shades; and the colouring. Invention consists principally in three things, the choice of a subject properly within the scope of the art; the seizure of the most striking and energetic moment of time for representation, and the discovery and selection of such objects, and such probable incidental circumstances, as, combined together, may best tend to devolve the story, or augment the interest of the piece. In this part of the art, there is a cartoon of Raphadl, which furnishes an example of genius and sagacity. It represents the inhabitants of Lystra about to offer sacrifice to Paul and Barnabas. It was necessary to let us into all the cause and hurry before us; accordingly, the cripple, whom they had miraculously healed, ap-

appears in the crowd: observes the means which the painter has used to distinguish this object, and of course to open the subject of his piece. His crutches, now useless, are thrown to the ground; his attitude is that of one accustomed to such support and still doubtful of his limbs: the eagerness, the impetuosity, with which he solicits his benefactors to accept the honours destined for them, points out his gratitude and the occasion of it. During the time he is thus busied, an elderly citizen of some consequence, by his appearance, draws near, and lifting up the corner of his vest, surveys with astonishment, the limb newly restored; whilst a man of middle age, and a youth, looking over the shoulder of the cripple, are intent on the same object. The wit of man could not devise means more certain of the end proposed. In the cartoon of Paul preaching at Athens, the elevated situation, and energetic action of the apostle, instantly denote him the hero of the piece, whilst the attentive but astonished circle gathered around him, receive as it were, light from him, their centre, and unequivocally declare him the resistless organ of divine truth.

Painting, as applied to purpose of building, is the application of artificial colours, compounded either with oil or water, in embellishing and preserving wood, &c. This branch of painting is termed *economical*, and applies more immediately to the power which oil and varnishes possess of preventing the action of the atmosphere upon wood, iron and stucco, by interposing an artificial surface. But it is here intended to use the term more generally, in allusion to the decorative part, and as is employed by the architect, throughout every part of his work. In every branch of painting in oil, the general processes are very similar, and with such variation only, as readily occur to the workman.

The first coatings, or layers, if on wood or iron, ought always to be of white lead of the best quality, previously ground very fine in nut or linseed oil, either over a stone, with a muller, or passed through a mill. If used on shutters, doors, or wainscoting, made of fir or deal, it is very requisite to destroy the effects of the knots; which generally, are so completely saturated with turpentine, as to render it perhaps, one of the most difficult, processes in this business. The best mode, in common cases, is, to pass a brush over the knots, with lead ground in water, bound by a size made of parchment or

glue; when that is dry, paint the knots with white lead ground in oil, to which add some powerful drier, as red lead, or litharge of lead; about one fourth part of the latter. These must be laid very smoothly in the direction of the grain of the wood. When the last coat is dry, smooth it with pumice stone, or give it the first coat of paint, prepared with nut or linseed oil; when dry, all nail holes or other irregularities must be stopped with a composition of oil and Spanish White. The work must then be again painted with white lead and oil, somewhat diluted with the essence of turpentine, which process should be repeated not less than three or four times, if a plain white or stone colour is intended; and if the latter colour, a small quantity of ivory or lamp black should be added. But if the work is to be finished of any other colour, either grey, green, &c. it will be requisite to provide for such color, after the third operation, particularly if it is to be finished flat, or as the painters style it, dead white, fawn, grey, &c. To finish a work flatted or dead, which is preferable mode for all superior works, one coat of the flatted colour, or colour mixed with a considerable quantity of turpentine will be found sufficient, although it will be frequently requisite to give large surfaces two coats of the flattening colour. For stucco it will be almost a general rule. In all these operations, some sort of drier is necessary; a very general and useful one is made, by grinding in linseed, (or, perhaps, preparted oils boiled, are better,) about two parts of the best white copperas, well dried with one part of litharge. —

The best drier for all fine whites, and other delicate tints, is sugar of lead, ground in nut oil: about the size of a walnut will be sufficient for 20 lbs. of colour, when the basis is white lead. Painter's utensils should be always kept very clean. If the colour should become foul, it must be passed through a fine sieve or canvass, and the surface of the work carefully rubbed down with sand paper or pumice stone. The latter should be ground in water, if the paint is tender. In general cases, perhaps two or three years are not too long to suffer stucco to remain unpainted. When it is on battened work it may be painted much sooner than when prepared on brick. For priming and laying on the first coat on stucco, take linseed or nut oil, boiled with driers as before mentioned; taking care in all cases not to lay on so much, as to render the surface rough, and no more than the stucco will absorb. It

should be covered with three or four coats of white lead, prepared as described for painting on wainscoting, letting each coat dry hard. If it is wished to give the work a grey tint, light green, &c. about the third coat prepare the ground for such tint, by a slight advance towards it. Grey is made with white lead, Prussian blue, ivory black, and lake; sage green, pea and sea greens, with white, Prussian blue, and fine yellow; apricot and peach, with lake, white, and Chinese vermilion: fine yellow fawn colour, with burnt terra sienna, or umber and white; and olive greens with fine Prussian blues and Oxfordshire ochre.

Distemper, or painting in water colour, mixed with size, stucco or plaster, if not sufficiently dry to receive oil, may have a coating in water colours, of any given tint required. Straw colours may be made with French white and ceruse, or white lead and massicot, or Dutch pink. Greys full, with some whites and refiner's verditure. An inferior grey may be made with blue black, or bone black and indigo; pea greens, with French green, Olympian green, &c. Fawn colour with burnt terra de sienna, or burnt umber and white, and so of any intermediate tint. Grind all the colours very fine, and mix with whiting and a size made with parchment, or some similar substance. Less than two coats will not be sufficient to cover the plaster, and present a uniform appearance. If it should be desirable to have the stucco painted in oil, the whole of the water colour should be removed, which can be easily done by washing, and when quite dry, proceed with it after the directions given in painting on stucco. If old plastering has become disfigured by stains, or other blemishes, and if it is desirable to paint in distemper, in this case, it is advisable to give the old plastering, when properly cleaned and prepared, one coat at least, of white lead ground in oil; and used with spirits of turpentine, which will generally fix old stains, and when quite dry, will take water colours very kindly.

*Directions for Painting in oil on Canvass.* After your cloth is nailed on the frame, pass over it a coat of size; when dry, rub it over with a pounce stone, to eat off all the knobs: the first size is intended to lay down all the threads, and fill up all the small holes, to prevent the colour from passing through. When the cloth is dry lay on a coat of simple colour, which may not destroy the others; for example, brown

red, which is a natural earth, full of substance and lasting. If mixed with a little white lead it will dry sooner. In grinding this colour, use nut or linseed oil, and it should be prepared to lay on as thin as possible. When this colour is dry, rub it again with the pounce stone, which renders it smoother: lay another coat of white lead and charcoal black, to render the ground greyish, having care in putting on as little colour as possible, to prevent the cloth from cracking, and for the better preservation of the colours to be laid afterwards. We will observe, that if there was no ground laid on the canvass of a picture, previous to painting it, and if painted directly on the bare cloth without any preparation, the colours would appear much more to their advantage, and preserve their brightness much longer. Some of the first mastess impregnate their canvass with water colours only, and paint afterwards in oil over the ground. This method renders pieces more lively and bright, because the ground in water colours draws and soaks the oil from the colours, rendering them finer; whereas, on the contrary, oil is the cause of this dulness, by its detention in their colours. It is desirable therefore, to use as little oil as possible; and in order to keep the colours stiff, mix with them a little of the oil of spike, which will evaporate very soon, but renders them more fluid and tractable in working. We cannot recommend too much care in keeping the colours (for the least tint might destroy the best design) unmixed, either with brush or pencil. When there is occasion to give more strength to some parts of the picture, let it be well dried before it is interrupted again. The custom prevails of grounding the canvass with oil colours; but when the canvass is good and very fine, the less colour which can be laid on for that purpose is preferable. Care is also requisite, that the colours and oils are good. The lead which some painters use to dry the sooner, soon destroys their brightness and beauty. In short, he shows his judgment in painting, who is not hasty in laying his colours, but lays them thick enough, and covers, at several times his carnations, which, in terms of art is called *empater*.

*Directions for Colouring Prints.* All the colours used for this purpose are ground with gum water, excepting calcined green. For complexions, a mixture of white and vermilion.

For the lips, lake and vermilion.

For the shades, white and vermilion, and considerable umber.

For the hair, white with very little umber; if a caroty colour, yellow ochre and brown red; the shade with bistre and lake, mixed together; if light, mix black, white, and umber together.

For the clothes, if linen, white lead and a little blue; if stuffs, white lead alone, and the shades with a grey colour, made by means of a mixture of black and white lead together. If a white cloth, a mixture of white and umber together, and shade with a compound of umber and black. If a red cloth, use vermilion in the lighter parts of the folds; lake and vermilion, for the clear shades; lake alone laid on the vermilion, will form the dark shades.

*Directions for mixing of Colours.* Pale yellow for lights—white massicot. The chiaro oscuro, with the massicot and umber. The dark shade, with umber alone.

*Orange.* Black lead, for the lights; shade with the lake. The lake is used very clear for the lights, in drapery, and thicker for the shades.

*Purple.* Blue, white, and lake, for lights; blue, and lake, only, for the clear shades; and indigo and blue for the darker ones. The pale blue is used for the lights; and for the clear shades, a little thicker; but for the darker shades, mix the indigo and blue together.

The gold like yellow is made with yellow massicot for the lights—clear shades, a mixture of black lead and massicot—dark shade, lake, yellow ochre, and a very little black lead: and darkest of all, cologne earth and lake.

The green is of two sorts. The first—massicot and blue, or blue and white; for the shade, make the blue predominate in the mixture. The other is made with calcined green, and their shades may be formed by the addition of indigo.

For trees, mix green and umber together. The grounds are made in the same way. For the distance, mix blue and green together. Mountains are always made with blue. The skies are made with blue, but add a little yellow when you come near the mountains, and to make the transition between that and the blue, mix a little lake and blue together to soften it.

Clouds are made with purple; if they be obscure, mix lake and indigo together. Stones are made with white and yellow mixed together; and their shades with black.

## CHAPTER XXII.

*Paints—Cosmetics—to imitate Marble—to dye Bones—Colours for show Bottles—for Maps—to imitate Ebony—to imitate Gold, Silver, or Copper—to whiten Bones—Colouring principles of Blood—Metalic Watering.*

**Patent Yellow.** Pulverise common table salt very finely; put it into Wedgwood's mortar; add to it twice as much red lead, pulverised: rub them well together first; then add water a very little at a time, and continue rubbing until a paste is formed. The muriate of lead will now be formed, and the soda disengaged; pour in a large quantity of water and wash it several times; the soda will wash out and leave a white mass; dry this mass and then melt it in a crucible, and a beautiful substance will be formed, called patent yellow, which is one of the most durable pigments.

2. Common salt 100 lbs. litharge 400 lbs. ground together with water; keep for some time in a gentle heat, water being added to supply the loss by evaporation, the natron then washed out with more water, and the white residuum heated till it acquires a fine yellow colour.

**Flake White.** Made by suspending rolls of thin sheet lead over vinegar in close vessels; the evaporation from the vinegar being kept up by the vessels being placed in a heap of manure, or a steam bath.

2. By dissolving litharge in diluted nitrous acid, and adding prepared chalk to the solution; astringent, cooling; used externally: also employed as paint, mixed with nut oil.

**Protoxid of Lead.** Melt some lead in a ladle, and scrape off the pellicle which forms on its surface several times, or until a sufficient quantity is obtained; part of this is oxidated and part is not; now put this into a ladle by itself: and expose it to a low red heat, continually stirring it with a rod until it becomes of a yellow colour.

This is the *massicot* used in the arts; also for setting a fine edge to razors, for polishing burnishers, &c.

**Red Lead.** Put some *massicot* into a ladle; cover it over loosely with an earthen or iron plate, and raise the heat; raise up one side of the plate, and stir it often, until it becomes of a bright red; care must be taken not to raise the heat so high as to drive off the oxygen, previously acquired;



thereby bringing it again to a state of pure melted lead; it is very difficult to succeed in this operation with small quantities.

This is the *red lead* used by painters; and it is on this principle, but with a different apparatus, the lead of the shops is manufactured; but it is generally very impure.

*Florence Lake.* Pearl ashes one ounce four drachms, water a sufficient quantity, dissolve; alum two ounces four drachms, water, q. p. dissolve; filter both solutions and add the first to the alum solution while warm; strain: mix the sediment upon the strained with the first coarse residuum obtained in boiling cochineal with alum, for making carmine, and dry it.

*Common Lake.* Make a magestery of alum, as in making Florence lake; boil one ounce four drachms Brazil dust in three pints of water, strain; add the magestery, or sediment of alum, to the strained liquor; stir it well; let it settle, and dry the sediment in small lumps.

*Fine Madder Lake.* Dutch grappé madder (that is, madder root ground between two mill stones, a small distance apart as in grinding pearl or French barley, so that only the bark, which contains the moist colour is reduced to powder, and the central woody part of the wood left) two ounces, tie it up in a cloth, beat it up in a pint of water in a stone mortar, repeat it with fresh water: in general five points will take out all the colour; boil, add one ounce of alum, dissolved in a pint of water, then add one ounce and a half of oil of tartar; wash the sediment, and dry;—produces half an ounce.

*Rose Pink.* Whiting coloured with a decoction of Brazil wood and alum.

*Dutch Pink.* Whiting coloured with a decoction of birch leaves, dyer's weed, or French berries, with alum.

*Stone Blue.* Starch coloured with indigo.

*Litharge.* Put some red lead into a ladle and heat it until it is partly melted, so that it begins to be agglutinated in a kind of scales. If not so bright a red it is a more durable colour.

*White Lead.* Make nitrate of lead as before directed, and dissolve it in water in a wine glass; pour into it a solution of pearlash and a white insoluble precipitate will fall down. Let the liquid be poured off, and the powder washed several

times. This is the *white lead* of painters in its purest state.

It is generally made by applying the vapour of vinegar to sheet lead, and contains some acetate of lead and other impurities.

*Sugar of Lead.* Put some white lead into a Florence flask; put in about ten times as much good sharp vinegar (distilled vinegar is best;) shake up several times and let it stand until the vinegar tastes sweet. Add more vinegar, and continue adding by littles, until it will remain sour; evaporate and crystallize in the usual way. This is the acetate or sugar of lead used in medicire.

*White Vitriol.* Pour diluted sulphuric acid upon zinc; leaving the zinc in excess: after the action ceases, pour off the clear liquids, which is the white vitriol in solution. If this be evaporated slowly, crystals will be formed.

By a similar process the vitriol of the shops is manufactured.

*Chrome.* Chrome is found in the state of an acid, combined with iron, called chromate of iron, it is sometimes found in granular lime rocks. When chromate of iron is pulverized and mixed with nitrate of potash and heated to redness, a double decomposition takes place, and the chromate of potash is produced.

Dissolve chromate of potash in pure water, pour some of it in a solution of sugar of lead, and the beautiful yellow pigment, chromate of lead, will be precipitated; pour it into nitrate of mercury, cinnabar red is produced; into nitrate of silver, and common red is produced.

The chromate of lead is now in general use as a yellow paint; a very small quantity mixed with white lead, gives the whole a beautiful yellow colour.

*Almond Bloom.* Brazil dust one ounce, water three pints, boil, strain; add of isinglass, six drachms; (or cochineal, two drachms;) alum one ounce; borax three drachms; boil again, and strain through a fine cloth; used as a liquid cosmetic.

*Blue Vitriol.* Boil copper filings in sulphuric acid, and the salt will be formed in the liquid state: this may be evaporated in the usual way.

On this principle the blue vitriol of the shops is made, though the operation is not similar; the native sulphuret is heated and exposed to air and moisture, and thereby the peroxyde is obtained; then the salt is readily formed by pouring sulphuric acid upon it.

*Verdigris.* Cover a gallipot of boiling vinegar with a piece of polished sheet copper; after a short time it will be covered with a thin crust of verdigris. Upon this principle, though with a very different apparatus, the verdigris of the shops is made.

*Colours for Show Bottles.* Yellow. Dissolve iron in spts. of salt, and dilute.

Red. Spts. of hartshorn q. p. dilute with water and tinge with cochineal.

2. Dissolve sal. ammoniac in water and tinge with cochineal.

Blue. Blue Vitriol and alum, of each 2 oz. water 24 oz. spts. of vitriol q. p.

2. Blue vitriol, 4 oz. water 36 oz.

Green. Rough verdigris 3 oz. dissolve in spts. vitriol, and add 48 oz. water.

Add distilled verdigris and blue vitriol to a strong decoction of turmeric.

Purple. Verdigris two drachms; spts. hartshorn 4 oz. water 18 oz.

2. Sugar of lead one ounce; cochineal one scruple; water q. p.

3. Add a little spirits hartshorn to an infusion of logwood.

*Wash Colours for Maps or Writing.* Yellow. Gamboge dissolved in water q. p. French berries steeped in water, the liquid strained, and gum Arabic added.

2. Red. Brazil dust steeped in vinegar and alum added.

Litmus dissolved in water, and spirits of wine added.

3. Cochineal steeped in water, strained, and gum added.

4. Blue. Saxon blue diluted with water q. p.

Litmus rendered blue by adding distilled vinegar to its solution.

5. Green. Distilled verdigris dissolved in water, and gum added.

6. Sap green dissolved in water, and alum added.

Litmus rendered green by adding kali ppm. to its solution.

*English Verdigris.* Blue vitriol 24 lbs. white vitriol 16 lbs. sugar of lead 12 lbs. alum 2 lbs. all coarsely powdered, put in a pot over the fire and stirred till they are united into a mass.

*Venetian Ceruss.* Flake white, cawk equal parts.

*Hamburg White Lead.* Flake white 100 lbs. cawk 200 lbs.

*Best Dutch White Lead.* Flake White 100 lbs. cawk 700 lbs.

*English White Lead.* Flake White reduced in price by chalk, inferior to the preceding.

*Rouge.* French chalk ppd. 4 oz. ol. amygd. 2 drachms, carmine one drachm.

2. Safflower, previously washed in water, until it no longer gives out any colour, and dried, 4 drachms, kali pp. one drachm, water one pint; infuse, strain; add French chalk, scraped fine with Dutch rushes four ounces, and precipitate the colour upon it with lemon juice a sufficient quantity.

*Cologne Earth, Umber.* Black or blackish brown, mixed with brownish red, fine grained, earthy, smooth to the touch, becomes polished by scraping, very light, burns with a disagreeable smell found near Cologne; used in painting both in water colours or in oil, used also in Holland, to render snuff fine and smooth: very different from the brown ochre—which is also called umber, and is not combustible.

*Carmine.* Boil one ounce of cochineal, finely powdered, in twelve or fourteen pounds of rain or distilled water, in a tinned-copper vessel, for three minutes, then add twenty-five grains of alum and continue the boiling for two minutes, then add twenty-five grains of alum and continue the boiling for two minutes longer, and let it cool; draw off the clear liquor as soon as it is only blood warm, very carefully, into shallow vessels, and put them by, laying a sheet of paper over them to keep out the dust for a couple of days, by which time the carmine will have settled. In case the carmine does not settle properly, a few drops of a solution of tin, i. e. dyer's spirit, or a solution of green vitriol will throw it down immediately: the water being then drawn off, the carmine is dried in a warm stove. The first coarse sediment serves to make Florence lake; the water drawn off is liquid rouge.

2. Boil 12 oz. of Cochineal powdered, six drachms of alum in 30 lbs. of water, strain the decoction, add half an ounce of dyer's spirit, and after the carmine has settled, decant the liquid and dry the carmine—yields about one and a half ounces, used as a paint by the ladies and by miniature painters.

*Whiting.* Prepared from the soft variety of chalk, by diffusion in water, letting the water settle for two hours, that the impurities and coarser particles may subside; then drawing off the still milky water, letting it deposite the finer sediment; is much finer than the prepared chalk of the apothecaries; but is principally used as a cheap paint.

*Ultramarine Blue.* Lapis lazuli—one pound is heated to redness, quenched in water, and ground to fine powder: to this is added yellow resin six ounces; turpentine, beeswax, linseed oil, of each two ounces, previously melted together, and the whole made into a mass: this is kneaded in successive portions of warm water, which it colours blue; and from whence it is deposited by standing, and sorted according to its qualities. It is a fine blue colour in oil.

*Naples Yellow.* Lead, one pound and a half; crude antimony, one pound; alum and common salt, of each one ounce, calcined together.

2. Flake white, twelve ounces; diaphoretic antimony, two ounces; calcined alum, half an oz. sal ammoniac, one ounce; calcine in a covered crucible with a moderate heat for three hours, so that at the end of that time it may be barely red hot: with a large portion of diaphoretic antimony and sal ammoniac, it verges to a gold colour.

*Scheele's Green.* Precipitate a solution of two pounds of blue vitriol in a sufficient quantity of cold water, by a solution of eleven ounces of white arsenic, and two ounces of kali ppm. in two gallons of boiling water, and wash the precipitate—used as a paint.

*Verditer Blue.* Made by the refiners from the solution of copper obtained in precipitating silver from nitric acid, by heating it in copper pans; this solution they heat and pour upon whiting moistened with water, stirring the mixture every day, till the liquor loses its colour, when it is poured off, and a fresh portion of the solution poured on until the proper colour is obtained:—an uncertain process; the colour sometimes turning out a dirty green, instead of a fine blue.

*French Verdigris.* Blue vitriol, twenty-four ounces, dissolved in a sufficient quantity of water; sugar of lead, thirty ounces and a half, also dissolved in water; mix the solution; filter, and crystallize by evaporation. It yields about ten ounces of crystals;—a superior paint to common verdigris,

and certainly ought to be used in medicine, instead of the common.

*Pearl powder.* Magestry of bismuth; French chalk, scraped fine by Dutch rushes; of each a sufficient quantity—*cosmetic.*

*Smalt—powder Blue.* Is made from roasted cobalt, melted with twice or thrice its weight of sand, and an equal weight of potash: the glass is poured out into cold water, ground to powder, washed over, and sorted by its fineness and the richness of its colour. It is used in painting and getting up linen.

*Blackman's oil colour Cakes.* Grind the colours first with oil of turpentine and a varnish made of gum mastic in powder, four ounces, dissolved without heat in a pint of oil of turpentine: let them dry; then heat a grinding stone by putting a charcoal fire under it; grind the colours upon it, and add an ointment, made by adding melted spermaceti, 3 lbs. to a pint of poppy oil; take a piece of the proper size, make it into a ball; put this into a mould and press it. When these cakes are used, rub them down with poppy oil, or oil of turpentine.

*Brown Red.* By recalcining green vitriol, previously calcined to whiteness, by an intense heat until it becomes very red, and washing the residuum.

*Blackman's Colours in Bladders.* Are prepared with the spermaceti mixture, like his oil colour cakes, but the proportion of oil is larger.

*Kemp's White, for Water Colours.* Cockscomb spar, q. p. spirits of salt, a sufficient quantity; dissolve—add carbonate of ammonia to precipitate the white; and dry in cakes for use.

*Crayons.* Spermaceti, three ounces, boiling water, one pint; add bone ashes finely ground, one pound, colouring matter, as ochre, &c. q. p. roll out the paste, and when half dry, cut it in pipes.

2. Pipe clay, coloured with ochre, &c. q. p.—make it a paste with alewort.

*English Verdigris.* Blue vitriol, 24 pounds, white vitriol, 16 pounds, sugar of lead, 12 pounds, alum, 2 lbs., all coarsely powdered, put into a pot over the fire and stirred till they are united into a mass.

*Vanherman's Fish Oil Paints.* The oil for grinding white

is made by putting litharge, and white vitriol, of each twelve pounds, into 32 gallons vinegar, adding after some time, a ton of whale, seal or cod oil; the next day the clear part is poured off, and 32 gallons of linseed oil, and two gallons of oil of turpentine, are added.

2. The sediment, left when the clear oil is poured off, mixed with half its quantity of lime water, is also used under the name of prepared residue oil, for common colours.

3. *Pale Green.* Six gallons of lime water, whiting, and road dust, of each one hundred weight, thirty pounds of blue black, 24 pounds of yellow ochre, wet blue (previously ground in prepared residue oil) twenty pounds; thin with a quart ppd. residue oil to each 8 pounds, and the same quantity linseed oil.

4. *Bright Green.* 100 lbs. yellow ochre, 150 lbs. of road dust, 100 lbs. of wet blue, 10 lbs. blue black, 6 galls. lime water, 4 galls. ppd. residue and linseed oil, seven and a half galls. of each.

5. *Lead Colour.* 100 lbs. whiting, 5 lbs. blue black, 28 lbs. white lead, ground in oil, 56 lbs. road dust, 5 galls. lime water, 2 1-2 galls. ppd. residue oil.

6. *Brown Red.* 8 galls. lime water, 100 lbs. Spanish brown, 200 lbs. dust, 4 galls. ppd. fish oil, ppd. residue and linseed oil, of each four gallons,

7. *Yellow.* Put in yellow ochre, instead of Spanish brown, as in the last.

8. *Black.* Put in lamp black or blue black.

9. *Stone Colour.* 4 galls. lime water. 100 lbs. whiting, 28 lbs. white lead, ground in oil, 56 lbs. road dust, 2 galls. ppd. fish oil, ppd. residue, and linseed oil, of each, 3 1-2 gallons.

The cheapness of these paints, and the hardness and durability given to them by the road dust, or ground gravel, has brought them into great use, for common out door painting.

*Prussian Blue.* Red argol and salt petre of each two lbs. throw the powder by degrees into a red hot crucible; dry bullock's blood over the fire, and mix three pounds of this dry blood with the prepared salt, and calcine it in a crucible, till it no longer emits a flame; then dissolve 6 lbs. of common alum in 26 lbs. of water, and strain the solution; dissolve also 2 1 2 oz. of dried green vitriol in 2 lbs. water, and strain while hot; mix the two solutions together, while boiling hot;

dissolve the alkaline salt, calcined with blood, in 27 lbs. of water, and filter through paper, supported upon linen; mix this with the other solution, and strain through linen; put the sediment left upon linen, while moist, into an earthen pan, and add one pound and a half of spirit of salt,—stir the mass and when the effervescence is over, dilute with plenty of water, and strain again—lastly, dry the sediment.

2. Mix one pound of kali ppd. with two pounds dried blood put it into a crucible, or long pot, and keep it in a red heat till it no longer flames or smokes, then take out a small portion, dissolve it in water, and observe its colour and effects upon a solution of silver in aqua-fortis, for when sufficiently calcined, it will neither look yellowish, nor precipitate silver of a brownish or blackish colour. It is then to be taken out of the fire; and when cool, dissolved in a pint and a half of water. Take green vitriol, one part, common alum, one to three parts; mix, and dissolve them in a good quantity of water, by boiling, and filter while hot: precipitate this solution by adding a sufficient quantity of the solution of ppd. alkali; and filter—the precipitate will be darker the less alum is added, but it will be greener from the greater admixture of the oxide of iron, which is precipitated, and which must be got rid of, by adding while moist, spirit of salt, diluting the mixture with water, and straining.

3. Precipitate a solution of green vitriol, with a solution of ppd. alkali, and purify the precipitate with spirits of salt—precipitate a solution of common alum, with a solution of kali ppd.—mix the two sediments together, while diffused in warm water; strain and dry.

*Vermilion. Cinnabar.* Put quicksilver in a glazed dish, set it on a sand bath, let it be well surrounded with sand every way; pour some melted brimstone over it, and with an iron spatula keep constantly stirring till the whole is converted into a black powder. With this powder fill the quarter part of a retort, with a short and wide neck. Place it first on a fire of cinders,—increase it by degrees, and continue it for ten hours; after which, make a blasting one twelve hours.

By the first fire there will arise a black flame—by the second, a yellow,—and by the last, a red. As soon as this is the case let the vessel cool, and you will find in the receiver, and in the neck of the retort, a very fine cinnabar. Some, instead of a glass retort, use an earthen, or stone.



*A Fine Azure.* Boil and skim well, sixteen pounds of chamber lye; then, add one pound fine shellac, and five ounces of alum, in powder. Boil all together, till you observe the chamber lye is well changed with the colour, which is determined by steeping a white rag in it—if the colour does not please, boil it longer, undergoing a repetition until satisfied. Now, put the liquor into a flannel bag—without suffering what runs into the pan under, to settle; re-pour it into the bag, and continue the process, till the liquor is quite clear and not tinged; then with a wooden spatula take off the lake, which is in the form of curd; make it into small cakes, and dry them in a shade on new tiles; then they are in a state to be kept for use.

*To Marble Wood.* Give it a coat of blacking varnish; repeat it as many times as you think necessary; then polish it.

2. Dilute some white varnish, lay it on the black ground, tracing with it, such imitations as you like; when dry, rub it lightly with rushes, then wipe it, and give a last coat of transparent white varnish, when dry, polish it.

*To imitate White Marble.* Break and calcine the finest white marble, grind it fine and dilute it with size; lay two coats of this on the wood, which, when dry, polish and varnish as before directed.

*To imitate Black Marble.* Burn lamp black in a ladle, red hot, then grind it with brandy. For the bulk of an egg of black, put the size of a pea in lead, in drops, as much of tallow, and the same quantity of soap—grind and mix; then dilute it with a very weak size water. Give four coats of this, and then polish.

*To make Lamp Black for limning.* Burn some nut shells in an iron pan, and throw them into another full of water; then grind them on marble with either oil or varnish.

*Blue.* Whiting ground with verdigris will make a very good blue.

*A Fine Green.* Grind verdigris with vinegar, and a very small quantity of tartar; then add a little quicklime and sap green, which grind with the rest, and put it into shells for keeping. If it becomes too hard, dilute it with vinegar.

2. Grind on a marble stone, verdigris, and a third as much of tartar, with white wine vinegar.

*Sap green.* Express the blackberry juice, when full ripe;

add some alum to it; put it in a bladder, and hang it in some place to dry.

*To make Lake.* Take three parts of an ounce of Brazil wood, a pint of clear water, one and a half drachms alum, eighteen grains salt of tartar; the bulk of two filberts of mineral crystal; three quarters of a pound of the whitest sound fish bones, rasped; mix, boil till reduced to one third; strain three times through a coarse cloth; then set it in the sun under cover to dry.

*A Liquid Lake.* On a quantity of alum and cochineal pounded and boiled together, pour drops of oil of tartar, until it becomes a fine colour.

*A Good Azure.* Two ounces of quicksilver; sulphur and sal ammoniac, of each one ounce: grind all together, and put it to digest in a matrass over a slow heat; increase the fire a little; and when you see an azured fume arising, take the matrass off. When cool, as beautiful an azure is produced as ultramarine.

*To dye Bones black.* Litharge and quicklime, of each six ounces; boil in common water, with the bones; stirring them till the water begins to boil; then take it from the fire, and continue stirring the mixture till the water is cold, when the bones will become dyed black.

*To Dye Bones green.* Pound well together in a quart of strong vinegar, three ounces of verdigris, as much of brass filings and a handful of rue. When done put all in a glass vessel along with the bones you wish to dye, and stop it well. Place this in a cold cellar; in a fortnight, the bones will be dyed green.

*To dye Bones and Ivory a fine red.* Boil scarlet flocks in clear water, assisted with pearlashes to draw the colour; then clarify it with alum, and strain the tincture through a piece of linen. To dye bones or ivory in red, you must first rub them with aqua fortis and then immediately with the tincture.

*To whiten Bones.* Put a handful of bran and quick lime together into a new pipkin, with sufficient quantity of water, and boil it. Boil the bones in this until freed from greasy particles.

*To Dye Wood red.* Soak chopped Brazil wood in oil of tartar; (or boil it in common water;) give the wood a coat of yellow, made of saffron, diluted in water; when dry,

give it several coats of the first preparation, till the hue becomes pleasing. When dry burnish it, and lay on a coat of drying varnish with the palm of your hand. If a very deep red is wanted, boil the brazil wood in water, by adding a small quantity of alum or quick lime.

*To Dye Wood White and to produce a fine Polish.* Finest English white chalk ground in subtile powder on marble; then let it dry; set it in a pipkin on the fire, with a weak sized water, having great care not to let it turn brown,—when hot, give first a coat of size to your wood; let it dry; then give one or two coats of the white over it. These being dry also, polish with the rushes, and burnish.

*To Dye in Polished Black.* Grind lamp black on marble with gum water; then put it into a pipkin, and with a brush give the wood a coat of this; when dry, polish.

*To imitate Ebony.* Infuse nut galls in vinegar, in which you have soaked rusty nails: rub the wood with this, let it dry, polish and burnish.

*To imitate Gold, Silver, or Copper.* Rock crystal pulverised very fine, put into water, warm it in a new pipkin, with a little size; then give a coat of it on the wood with a brush. When dry, rub a piece of gold, silver, or copper on the wood thus prepared, and it will assume the colour of the metal which you rub it with; after which burnish.

*Ivory Black.* Is made by burning ivory till it is quite black, which is usually done between two crucibles, well luted together; used either as an oil or water colour.

*Bone Black.* From bones burnt in the same manner, as ivory black; used by painters, &c. Burnt cork is also used.

*Of the Colouring principle of Blood.* After having drained the clots of blood through a hair sieve, tincture it in an earthen vessel, with four parts of sulphuric acid, previously diluted with eight parts of water, and heat the mixture at 70° (cent.—158 deg. Fahrenheit.) for five or six hours: filter the liquor while hot, which contains the colouring principles of the blood, albumen, and probably some fibrin; wash the residuum with water, equal in quantity to that of the acid employed; evaporate the solutions to one half their bulk, then pour in ammonia sufficient to leave only a slight excess of acid; stir it, and we obtain a deposite of a purple red colour, principally consisting of the colouring matter, and containing neither albumen, nor fibrin; wash this deposite until the wa-

ter contains no more sulphuric acid, or does not precipitate any longer the nitrate of barytes: it is then put on a filter, and dropped on blotting paper, from which it is taken by means of an ivory knife and dried on a capsule.

*Prepared Ox Gall.* The fresh gall is left for the night to settle; the clear fluid poured off, and evaporated in a water bath, to a proper consistence; used by painters in water colours, and thus enables them to form an even surface of colour; and also instead of soap to wash greasy cloth.

*Cobalt*, is sold in the shops in the state of an imperfect oxide, called zaffre. The pure metal is reddish grey.

Mix finely pulverized flint and borax, and put in a small quantity of zaffre. Melt this mixture with pretty strong heat in a crucible, and a strong blue glass will be produced. Or, put a little zaffre in borax alone, or in pearlash, and melt the mixture.

The smalt sold in shops in powder is merely pulverized glass prepared as above.

*Metallic Watering, or for Blanc Moire.* This article of Parisian invention, which is much employed to cover cabinet ornamental work, dressing boxes, telescopes, &c. is prepared as follows: dilute sulphuric acid, with from 7 to 9 parts of water; then dip a sponge or rag into it, and wash the surface of a sheet of tin; this will speedily exhibit the appearance of crystallization, which is the moire. This effect is not easily produced upon every sort of sheet tin; for if much hardened by hammering and rolling, then the moire cannot be effected until the sheet has been heated so as to produce an incipient fusion on the surface, after which the acid will act upon it, and produce an incipient fusion on the surface, after which the acid will act upon it, and produce the moire. Almost any acid will do as well as the sulphuric, and it is said the nitric acid, dissolved in a sufficient quantity of water, answers better than any other. The moire can be much improved by employing the blow-pipe, to form small and beautiful specks on the surface of the tin, previous to the application of the acid. When the moire has been formed, the plate is to be varnished and polished, the varnish being tinted with any glazing colour, and thus the red, green, yellow, and pearl coloured moires are manufactured.

*Zaffre.* One part of roasted cobalt, ground with two or three parts of very pure quartzose sand; is either in a cake

or reduced to powder : used as a blue colour for painting glass.

*Purple Precipitate; Cassin's Purple.* Solution of gold in aqua-regia, 1 oz. distilled water, 1 1-2 lb.; hang it in the liquid slips of tin.

2. By precipitating the diluted solution of gold, by dyer's spirit, will communicate a purple colour to glass, when melted in an open vessel. In a close vessel the glass receives no colour.

## CHAPTER XXIII.

*Varnishes—to give a Drying Quality to Oils—Oils—Japans  
—Bronzing Liquor—Invisible Inks.*

*To make White Copal Varnish.* 1. White oxide of lead, cerused, Spanish white, white clay. Such of these substances as are preferred ought to be carefully dried. Ceruse and clays obstinately retain a great deal of humidity, which would oppose their adhesion to drying oil or varnish. The cement then crumbles under the fingers, and does not assume a body.

2. On 16 ounces melted copal, pour 4, 6, or 8 ounces of linseed oil, boiled and quite free from grease; when well mixed by repeated stirrings, and after they are pretty cool, pour on 16 ounces of the essence of Venice turpentine. Pass the varnish through a cloth.

*Amber Varnish,* is made in the same way.

*Black.* Lampblack made of burnt vine twigs, and black of peach stones. The lampblack must be carefully washed, and afterwards dried. Washing carries off a great many of its impurities.

*Yellow.* Yellow oxide of lead of Naples and Montpellier, both reduced to impalpable powder. These yellows are hurt by the contact of iron and steel; in mixing them up, therefore, a horn spatula, with a glass mortar and pestle must be employed. Gum guttæ, yellow ochre, or Dutch pink, according to the nature and tone of the colour to be imitated.

*Blue.* Indigo, Prussian blue, blue verditure, and ultramarine. All these substances must be very much divided.

*Green.* Verdigris, crystalized verdigris, compound green, (a mixture of blue and yellow.) The first two require a mixture of white in proper proportions, from a fourth to two-

thirds, according to the tint intended to be given. The white used for this purpose is the ceruse, or the white oxide of lead, or Spanish white, which is less solid.

*Red.* Red sulphuretted oxide of mercury, (cinnabar vermillion,) red oxide of lead, (minium) different red ochres, or Prussian reds, &c.

*Purple.* Cochineal, carmine, and carminated lakes, with ceruse, and boiled oil.

*Brick.* Dragon's blood.

*Chamois Colour.* Dragon's blood, with a paste composed of flowers of zinc; or, what is still better, a little red vermillion.

*Violet.* Red sulphuretted oxide of mercury, mixed with lampblack, washed very dry, or with the black of burnt vine twigs; and to render it more mellow, a proper mixture of red, blue and white.

*Pearl Grey.* White and black, white and blue; for example, ceruse and lampblack; ceruse and indigo.

*Flaxen Grey.* Ceruse, which forms the ground of the paste, mixed with a small quantity of Cologne earth, as much English red. or carminated lake, which is not so durable, and a particle of Prussiate of iron. (Prussian blue.)

*For Violins, &c.* To a gallon of rectified spirit of wine, add six ounces of gum sandarac, three ounces of gum mastic, and half a pint turpentine varnish. Put the whole into a tin can, which keep in a warm place, frequently shaking it, for twelve days, until it is dissolved. Then strain and keep it for use.

*To make a colourless Copal Varnish.* In selecting such pieces as are good, as all copal is not fit for this purpose, each piece must be taken separately;—let fall on it, a drop of pure essential oil of rosemary, not altered by keeping. The pieces which soften at the part that imbibes the oil are good: reduce them to powder, which sift through a very fine hair sieve, and put it into a glass, on the bottom of which it must not lie more than a finger's breadth thick. Pour upon it essence of rosemary to a similar height; stir the whole for a few minutes, when the copal will dissolve into a viscous fluid; let it stand for two hours, then pour on to it gently, two or three drops of very pure alcohol, which distribute over the oily mass by inclining the bottle in different directions with a very gentle motion: repeat this operation by little and little till the in-

corporation is effected, and the varnish reduced to a proper degree of fluidity. It must then be left to stand a few days, and when very clear, be decanted off.

This varnish thus made without heat, may be applied with equal success, to pasteboard, wood, and metals, and takes a better polish than any other. It may be used on paintings, the beauty of which it greatly heightens.

*Gold coloured Copal Varnish.* One ounce copal in powder, two ounces essential oil of lavender, and six ounces essence of turpentine. Put the oil of lavender into a matrass of proper size, placed on a sand bath, heated by a lamp, or over a moderate coal fire; add to the oil while very warm, and at several times, the copal powder, stir the mixture with a stick of white wood, rounded at the end; when the copal has entirely disappeared, add at three different times, the essence almost in a state of ebullition, and keep continually stirring the mixture. When the solution is completed, the result will be a varnish of gold colour, exceedingly durable and brilliant, but less drying than the preceding.

2. To obtain this varnish colourless, it will be proper to rectify the essence of the shops, which is often highly coloured, and to give it the necessary density by exposure to the sun in bottles closed with cork stoppers, leaving an interval of some inches between the stopper and the surface of the liquid; a few months are thus sufficient to communicate to it the required qualities; besides, the essence of the shops is rarely possessed of that state of consistence, without having at the same time a strong amber colour.

The varnish resulting from the solution of copal in oil of turpentine brought to such a state as to produce a maximum of solution, is exceedingly durable and brilliant. It resists the shock of hard bodies much better than the enamel of toys, which often becomes scratched and whitened by the impression of repeated friction; it is applied with greater success to philosophical instruments; and the paintings with which vessels and other utensils of metal are decorated.

2. Four ounces copal, and one ounce clear turpentine. Put the copal, coarsely pulverized, into a varnish pot, and give it the form of a pyramid, which must be covered with turpentine. Shut the vessel closely, and placing it over a gentle fire, increase the heat gradually, that it may not attack the copal; as soon as the matter is well liquified, pour it upon a plate of copper, and when it has resumed its consistence reduce it to powder. Put half an ounce of this powder into a

matrass with four ounces of the essence of turpentine, and stir the mixture till the solid matter is entirely dissolved.

*Camphorated Copal Varnish*, is designed for articles which require durability, pliability, and transparency. Two ounces pulverized copal, six ounces essential oil of lavender, one-eighth of an ounce camphor, and essence of turpentine, a sufficient quantity, according to the consistence required to be given to the varnish. Put into a phial of thin glass, or into a small matrass, the oil of lavender and the camphor, and place the mixture on a moderately open fire, to bring them to a slight state of ebullition; then add the copal powder in small quantities, which must be renewed as they disappear in the liquid. Favour the solution by continually stirring it with a stick of white wood; and when the copal is incorporated with the oil, add the turpentine boiling; but care must be taken to pour in, at first, only a small portion.

This varnish is little coloured, and by rest it acquires a transparency which, united to the solidity observed in almost every kind of copal varnish, renders it fit to be applied with great success in many cases, and particularly in the invention substituting varnished metallic gauze, used for the cabin windows of ships, as presenting more resistance to the concussion of air, during the firing of guns, in the room of Muscovy tale, a kind of mica, in large laminæ.

*Fat Amber or Copal Varnish*. Four ounces of amber or copal of one fusion, fourteen ounces essence of turpentine, and ten ounces of drying linseed oil. Put the whole into a pretty large matrass, and expose to the heat of balneum mariæ, or move it over the surface of an uncovered chafing dish, but without flame, and at the distance from it to two or three inches. When the solution is completed; add still a little copal or amber to saturate the liquid: then pour the whole on a filter prepared with cotton; and leave it to charify by rest. If the varnish is too thick, add a little warm essence to prevent the separation of any of the amber.

This varnish is coloured, but far less so than those composed by the usual methods. When spread over white wood, without any preparation, it forms a solid glazing, and communicates a slight tint to the wood.

If it be required to change this varnish with more copal, or prepared amber, the liquid must be composed of two parts of essence for one of oil.

*Compound Mastic Varnish*. Thirty-two ounces of pure alcohol, six ounces of purified mastic, three ounces of gum



sandarac, ounces of very clear Venice turpentine, and four ounces of glass, coarsely pounded.

Reduce the mastic and sandarac of fine powder; mix with white glass, from which the finest parts have been separated by a hair sieve; put all the ingredients, with alcohol, into a short necked matrass, adapted to a stick of white wood rounded at the end, the length proportioned to the height of the matrass, that it may be put in motion. Expose the matrass in a vessel filled with water, made at first a little warm, and which must afterwards be maintained in a state of ebullition for one or two hours. The matrass may be made fast to a ring of straw.

When the solution is sufficiently extended, add the turpentine, which must be kept separately in a phial, or pot, and which must be melted, by immersing it in a *balnæum mariæ* for a moment; the matrass must be still left in the water for half an hour, when it may be taken off, and the varnish stirred till somewhat cool. Next day draw off and filter through cotton. By these means it will become exceedingly limpid. The addition of glass may appear extraordinary; but it divides the parts of the mixture, which has been made with the dry ingredients, and the same quality is retained when placed over the fire. It obviates with success two inconveniences very troublesome to those who compose varnishes. First, by dividing the matters, it facilitates the action of the alcohol, and in the second, its weight, which surpasses that of resins; prevents these resins from adhering to the bottom of the matrass, and also the coloration acquired by the varnish, where a sand bath is employed, as is commonly the case. The application of this varnish is suited to articles belonging to the *toilette*; such as dressing boxes, cut paper work, &c. The following possesses the same brilliancy and lustre, but have more solidity, and are very drying.

*Camphorated Mastic Varnish for Paintings.* Twelve ounces mastic, cleaned and washed, one and a half ounces pure turpentine, and a half ounce of camphor, five ounces white glass, pounded, and thirty-six ounces ethereous essence of turpentine. Make it according to the method indicated for that of the first genus. The camphor is employed in pieces; the turpentine added, when the solution of resin is completed. If the varnish is to be applied to old paintings, or those which have been already varnished, the turpentine

may be suppressed, as it is recommended here, only in cases of a first application to paintings, and just freed from white of egg varnish. The ethereous essence recommended, is that distilled slowly, without any intermediate substance, according to the second process already given for its rectification.

The question by able masters has never yet been determined respecting the kind of varnish proper to be employed for paintings. Some artists have paid particular attention to this object, and make a mystery of the means they employ. The real end may be obtained by giving the varnish, destined for painting, pliability and softness, without being too solicitous in regard to what may add to its consistence or durability. The latter quality is particularly requisite in those which are to be applied to articles much exposed to friction, as boxes, furniture, &c.

*To make Painter's Cream.* Painters who have long intervals between their periods of labour, are accustomed to cover the parts they have painted with a preparation which preserves the freshness of the colours, and which they can remove when they resume their work. The preparation is as follows:

Three ounces very clean nut oil, half an ounce mastic in tears, pulverized, and one-third of an ounce sal saturni, in powder. Dissolve the mastic oil over a gentle fire, and pour the mixture into a marble mortar, over the pounded salt of lead; stir it with a wooden pestle; and add water in small quantities; till the matter assumes the appearance and consistence of cream, and refuses to admit more water.

*Sandarac Varnish.* Eight ounces gum sandarac, two ounces pounded mastic, four ounces clear turpentine; four ounces pounded glass, and thirty-two ounces alcohol; mix and dissolve as before.

*Compound Sandarac Varnish.* Three ounces pounded copal, of an amber colour; once liquified, six ounces gum sandarac, three ounces mastic, cleaned, two and a half ounces clear turpentine, four ounces pounded glass, and thirty-two ounces pure alcohol. Mix these ingredients, pursuing the same method as above.

This varnish is destined for articles subject to friction, such as furniture, chairs, fan sticks, mouldings, &c. and even metals, to which it may be applied with success. The sandarac gives it great durability.

*Camphorated Sandarac Varnish for Cut Paper Work, Dressing Boxes, &c.* 1. Six ounces sandarac, four ounces gum elemi, one ounce gum anima, half an ounce camphor, four ounces pounded glass and thirty-two ounces alcohol.

Make the varnish according to directions already given. The soft resins must be pounded with the dry bodies; camphor to be added in small pieces.

2. Six ounces gailipot or white incense, two ounces gum anima, two ounces pounded glass, and thirty-two ounces alcohol. Make the varnish with the precautions indicated for the compound mastic varnish. The two last varnishes are to be used for ceilings and wainscoats, coloured or otherwise: they may be employed as a covering to parts painted with strong colours.

*Spirituous Sandarac Varnish for Wainscotting, Small Articles of Furniture, Balustrades, and Inside Railing.* Six ounces of gum sandarac, two ounces of shell-lac, four ounces of colophonium or resin, four ounces white pounded glass, four ounces of clear turpentine and thirty-two ounces of pure alcohol. Dissolve the varnish as before directed for compound mastic varnish. This varnish is sufficiently durable to be applied to articles destined to daily and continual use.—Those composed with cepal, in these cases ought to be preferred.

2. There is another composition, which without forming part of the compound varnishes is employed with success for giving a polish and lustre to furniture made of wood: wax forms the basis of it. Many cabinet makers are contented to wax common furniture. This covering by means of repeated friction, soon acquires a polish and transparency which resembles those of varnish. Waxing seems to possess qualities peculiar to itself: but like varnish is attended with inconveniences as well as advantages. Varnish supplies better the part of glazing; it gives a lustre to the wood which it covers, and heightens the colours of that destined in particular, for delicate articles. These real and valuable advantages are counterbalanced by its want of consistence; it yields too easily on the shrinking or swelling of the wood, and rises in scales or slits, on being exposed to the slightest shock. These accidents can be repaired only by a new strata of varnish. Waxing stands shocks, but has not the property of giving lustre to the bodies on which it is applied, in the same degree as varnish, and of heightening their tints. The lustre it communicates is dull, but the inconvenience is compensated, by the facility which any accident that may have altered its polish can be repaired, by rubbing it with a piece of fine cork.

The application of wax under some circumstances, therefore ought to be preferred to that of varnish. This seems to be the case in particular with tables, exposed to daily use, and all articles subject to constant employment. The stratum of wax should be made as thin as possible, that the veins of the wood may be more apparent; therefore the following process may be acceptable to the reader. Melt over a moderate fire, in a very clean vessel, two ounces of white or yellow wax; when liquified, add four ounces good essence of turpentine; stir the whole, until entirely cool, and a kind of pomade is produced, which must be rubbed over furniture according to the usual method. The essence of turpentine is soon dissipated, but the wax by which its mixture is reduced to a state of very great division, may be extended with more ease, and in a more uniform manner. The essence soon penetrates the pores of the wood, calls forth the colour of it, causes the wax to adhere better, and the lustre which then results is equal to that of varnish.

*Coloured Varnish for Violin, and other stringed Instruments, also for Plumb Tree, Mahogany and Rose Wood.*—Four ounces of gum sandarac, two ounces of seed-lac, two ounces of mastic, one ounce of Benjamin in tears, four ounces of pounded glass, two ounces of Venice turpentine, and thirty-two ounces of pure alcohol.

The gum sandarac and seed lac render this varnish durable; it may be coloured with a little dragon's blood or saffron.

*Fat Varnish of a Gold Colour.* Eight ounces of amber, two ounces of gum lac, eight ounces of drying linseed oil, and sixteen ounces essence of turpentine. Dissolve separately the gum lac, and then add the amber, prepared and pulverized with the linseed oil and essence very warm. When the mixture has lost part of its heat, mix in relative proportions, tinctures of arnotto, terra merita, gum guttæ and dragon's blood. This varnish when applied to white metals, gives them a gold colour.

*Fat Turpentine, or Gold Varnish, being a mordant to gold and dark colours.* Sixteen ounces boiled linseed oil, eight ounces Venice turpentine, and five ounces Naples yellow. Heat the oil with the turpentine, and mix the Naples yellow pulverized. Naples yellow is an oxide of lead; it is substituted here for resins on account of its drying qualities,

and in particular, of its color, which resembles that of gold; great use is made of the varnish in applying gold leaf.

The yellow may be omitted when this species of varnish is to be solid and used on coloured coverings; in this case an ounce of litharge to each pound of composition may be substituted, without this mixture doing an injury to the colour of which it is to constitute the ground.

*Turner's Varnish for Boxwood.* Five ounces seed-lac, two ounces gum sandarac, one ounce and a half gum elemi, two ounces Venice turpentine, five ounces pounded glass, and twenty-four ounces pure alcohol. The artists of St. Claude do not all employ this formula, which required to be corrected on account of its too great dryness, which is here lessened by the turpentine and elemi.

This composition is secured from cracking, which disfigures these boxes after having been used for some months.

2. Other turners use gum lac united to a little elemi and turpentine digested some months in pure alcohol exposed to the sun. In pursuing this method, substitute for the sandarac, the same quantity of gum lac reduced to powder, and not to add the turpentine to the alcohol (which ought to be very pure) till towards the end of the fusion. Solar infusion requires care and attention; vessels of sufficient size to allow the spirituous vapours to circulate freely, ought to be employed, because it is necessary that the vessel should be closely shut. Without this precaution the spirits would become weakened, and abandon the resin which they laid hold of during the first days of exposure. This perfect obituration will not admit of the vessels being too full. In general, the varnishes applied to articles which may be put in the lathe acquire a great deal of brilliancy by polishing; a piece of woollen cloth is sufficient for the operation. If turpentine predominates too much in these compositions, the polish does not retain its lustre, because the heat of the hands is capable of softening the surface of the varnish, and in this state it readily tarnishes.

*To varnish Dressing Boxes.* The most of spirit of wine varnishes are destined for covering preliminary preparations, which have a certain degree of lustre. They consist of cement coloured or otherwise, charged with landscapes and figures cut into paper, which produces an effect under the transparent varnish; most of the dressing boxes, and other

small articles of the same kind, are covered with this particular composition, which, in general, consists of three or four coatings of Spanish white, poured in water and mixed with parchment glue. The first coating is smoothed with pumice stone, and then polished with a piece of new linen and water. The coating in this state is fit to receive the destined colour, after it has been ground with water. The cut figures with which it is to be embellished, are then applied, and a coating of gum, or fish glue is spread over them, to prevent the varnish from penetrating to the preparation, and from spoiling the figures. The operation is finished by applying three or four coatings of varnish, which, when dry are polished with tripoli and water by means of a piece of cloth. A lustre is then given to the surface, with starch and a bit of doe skin, or very soft cloth.

*Gallipot Varnish.* Twelve ounces gallipot or white incense, five ounces glass pounded, two ounces Venice turpentine, and thirty-two ounces essence of turpentine. Make the varnish after the white incense has been pounded with glass. Some recommend mastic or sandarac in the room of gallipot; but it is neither more beautiful nor durable; when the colour is ground with the preceding varnish and mixed up with the latter, which, if too thick, is thinned with a little essence, and which if applied immediately, without any sizing to boxes and other articles, the coatings acquire sufficient strength to resist the blows of a mallet. But if the varnish be applied to a sized colour, it must be covered with a varnish of the first or second genus.

*Mastic Gallipot Varnish, for Grinding Colours.* Four ounces new gallipot or white incense, two ounces mastic, six ounces Venice turpentine, four ounces pounded glass, and thirty-two ounces essence turpentine. With the precautions already indicated, add prepared nut oil, or linseed oil, two ounces. The matters ground with this varnish dry more slowly; they are then mixed up with the following varnish, if it be for common painting, or with particular varnishes destined for colours and for grounds.

*Mordant Varnish for Gilding.* One ounce mastic, one ounce gum sandarac, half an ounce gum guttæ, quarter of an ounce turpentine, and six ounces essence turpentine. Some artists who make use of mordants, substitute for the turpentine, an ounce of the essence of lavender, which renders this

composition less drying. In general the composition of mordants admits of modifications, according to the work for which they are destined. The application of them, however, is chiefly confined to gold. When it is required to fill up a design with gold leaf on any ground whatever, the composition which is to serve as the means of union between the metal and the ground; ought neither to be too thick or fluid; because both these circumstances are equally injurious to delicacy in the strokes; it will be requisite, also, that the composition should not dry till the artist has completed his design.

*Other Mordants.* 1. Some prepare their mordants with Jew's pitch and drying oil diluted with essence of turpentine. They employ it for gilding pale gold, or for bronzing. Others imitate the Chinese, and mix with their mordants colours proper for assisting the tone which they are desirous of giving to the gold, such as yellow, red, &c. Others employ fat varnish, to which they add a little red oxide of lead. Others use thick glue, in which they dissolve a little honey. This is what they call *battaze*. When they wish to heighten the colour of the gold, this glue is employed, to which the gold leaf adheres extremely well.

2. The qualities of the following are fit for any kind of application, and particularly to metals. Expose boiled oil to a strong heat in a pan; when a black smoke is disengaged from it, set it on fire, and extinguish it in a few minutes after, by putting on the cover of the pan. Then pour the matter still warm, into a heated bottle, and add to it a little essence of turpentine.

This mordant dries very speedily; it has body, and adheres to, and strongly retains, gold leaf, when applied to wood, metal, and other substances.

*Varnish for Pails and other coarse Wood work.* Take any quantity of tar, and grind it with as much Spanish brown as it will bear, without rendering it too thick to be used as a paint or varnish, and then spread it on the pails, or other wood, soon as convenient, for it quickly hardens by keeping. This mixture should be laid on by a large brush, the work to be kept free from dust and insects as possible, till the varnish is perfectly dry. On wood it will have a very good gloss, is an excellent preservative against moisture, on which account,

as well as its being cheaper, it is far preferable to painting, not only for pails, but for weather-boarding and all other kinds of wood work for gross purposes.

When the glossy brown colour is not liked, the work may be made of a greyish brown, by mixing a small proportion of white lead, or whiting and ivory black, with the Spanish brown.

*A Black Varnish for old Straw or Chip Hats.* Half an ounce of the best black sealing wax, two ounces of rectified spirits of wine. Powder the wax, put it with the spirits into a four ounce phial; digest them in a sand heat, or near the fire till the wax is dissolved; lay it on warm with a fine soft hair brush, before a fire or in the sun. It produces a stiffness to old straw hats, and gives a beautiful gloss, and resists wet.

*To make Varnish for Colored Drawings.* One ounce Canada balsam, two ounces spirits of turpentine: mix them together. Before this composition is applied, the drawing or print should be sized with a solution of isinglass in water; and when dry, apply the varnish with a camel's hair brush.

*To make a Varnish for Wood which resists the action of boiling water.* One and a half pounds of linseed oil, boil it in a red copper vessel, not tinned. Suspend over it in a small linen bag, five ounces litharge, and three ounces pulverized minium, taking care that the bag does not touch the bottom of the vessel; continue the ebullition till the oil acquires a dark brown colour, then take away the bag and substitute another in its place, containing a clove or garlic; continue the ebullition, and renew the clove or garlic seven or eight times, or rather put them all in at once. Then throw into the vessel a pound of yellow amber, when it is melted in the following manner; add to the pound of amber, well pulverized, two ounces linseed oil; place the whole on a strong fire. When the fusion is complete, pour it boiling into the prepared linseed oil, and continue to leave it boiling for two or three minutes, stirring the whole up well. It is then left to settle; the composition is decanted and preserved, when it becomes cold, in well corked bottles. After polishing the wood on which this varnish is to be applied, give the wood the colour required. When the colour is perfectly dry, apply the varnish with a fine sponge; repeat three or four times, taking care the preceding coat is well dried.



*To varnish Drawing and Card Work.* Boil some clean parchment cuttings in water, in a glazed pipkin, till they produce a very clear size. Strain it and keep it for use. Give the work two coats of the size, passing the brush quickly over the work, not to disturb the colours.

*A Composition for making Coloured Drawings and Prints resemble Paintings in Oil.* One ounce Canada balsam, two ounces spirits of turpentine; mix together. Before the composition is applied, the drawing or print should be sized with a solution of isinglass in water. When dry, apply the varnish with a camel's hair brush.

*To varnish Harps and Dulcimers.* Prepare the work with size and red ochre, then take ochre, burnt umber, and red lead, well ground, and mix up a dark brown colour in turpentine varnish, adding so much oil of turpentine that the brush may just be able to pass over the work fair and even. While yet wet, take a muslin sieve, and sift as much Dutch metal, previously powdered upon it, as is requisite to produce the effect, after which varnish, and polish it.

*To varnish Glass.* Pulverize a quantity of gum adragant; let it dissolve for twenty-four hours in the white of eggs beat up; then rub it gently on the glass with a brush.

*To varnish Balloons.* Dissolve elastic gum, cut small, in five times its weight of rectified essential oil of turpentine, by keeping them together; then boil one ounce of this solution in eight ounces drying linseed oil for a few minutes; strain the solution and use it warm. The elastic resin, known by the name of India rubber has been much extolled for a varnish. The foregoing method as practised by M. Blanchard may not prove unacceptable.

*To varnish rarified Air Balloons.* M. Cavallo, recommends first to soak the cloth in a solution of sal ammonia and common size, using one pound of each to every pound of water: and when quite dry, to paint over the inside with some earthy colour, and strong size or glue, when this paint has dried thoroughly, it will then be proper to cover it with oily varnish, which might dry before it could penetrate quite through the cloth. Simple drying linseed oil will answer the purpose as well as any, provided it be not very fluid.

*To paint Sail Cloth, &c. so as to be pliant, durable, and impervious to water.* Grind ninety-six pounds English ochre, with boiled oil, add sixteen pounds black paint, which mix-

ture forms an indifferent black. A pound of yellow soap, dissolved in six pints of water over the fire, is mixed while hot with the paint. This composition is then laid upon the canvass, (without being wetted, as in the usual way,) as stiff as can be conveniently done with the brush, so as to form a smooth surface; the next day, or still better, on the second day, a second coat of ochre and black, (without any, or but a very small portion of soap,) is laid on and allowing this coat an intermediate day for drying the canvass is then finished with black paint as usual. Three days is allowed for it to dry and harden; it will not stick together when taken down, and folded in cloth, containing sixty or seventy yards each; and canvass finished entirely with the composition, leaving it to dry one day between each coat, will not stick together if laid in quantities. It has been ascertained from actual trials, that the solution of yellow soap is a preservative to red, yellow and black paints, when ground in oil and put into casks, as they acquire no improper hardness and dry in a remarkable manner when laid on with a brush, without the use of the usual drying articles.

It is surprising that the adaption of soap, which is so well known to be miscible with oily substances, or, at least, the alkali of which it is composed, has not been brought into use, in the composition of all colours.

*Colouring Compositions for rendering Linen and Cloth impenetrable to water.* Begin by washing the stuff with hot water, then dry and rub it between the hands until it becomes perfectly supple; afterwards spread it out, by drawing it into a frame, and give it with the aid of a brush, a first coat, composed of a mixture of eight quarts of boiling linseed oil, calcined amber and acetate of lead seven and a half grammes, to which add ninety grammes of lampblack. Use the same ingredients for the second coat, except the calx of lead. This coat will give a few hours, according to the season, afterwards take a dry plasterer's brush and rub the stuff strongly with it, when the hair, by this operation will become extremely smooth. The third and last coat will give a perfect and durable jet black. Or rather take twelve quarts boiling linseed oil, thirty grammes of amber, fifteen grammes of acetate of lead, seven and a half sulphate of zinc, fifteen Prussian blue, and 120 grammes of lampblack. These coats are used at discretion as is done with painting.

*To thicken Linen Cloth for Screens and Bed Testers.*

Grind whiting with zinc; to prevent cracking, add a little honey; then take a soft brush and lay it upon the cloth; repeat this two or three times, but letting it dry between the layings; and for the last laying smooth it over with Spanish white, ground with linseed oil, the oil being first heated, and mixed with a small quantity of litharge, the better to endure the weather, and to be more lasting.

*Common Wax or Varnished Cloth.* Common canvass of an open and coarse texture, is stretched on frames, placed under sheds, with the sides open, to afford a free passage to the external air. The cloth is fastened to these frames, by hooks, which catch the edge of the cloth, and by strong pack-threads passing through holes at the other extremity of the hooks, which are tied round moveable pegs at the lower edge of the frame. The mechanism by which the strings of a violin are stretched or unstretched will give an idea of the arrangement of the pegs employed for extending the cloth in this apparatus. By this means the cloth can be easily stretched or relaxed, when the oily varnish has exercised an action on its texture in the course of the operation. The whole being thus arranged, a liquid paste made with drying oil, which may be varied at pleasure, is applied to the cloth.

*To make liquid Paste and Drying Oil.* Mix Spanish white, or tobacco pipe clay with water, and leave at rest for some hours, to separate the argillaceous parts and to produce a sediment. Stir the sediment with a broom, to complete the division of earth. After it has rested some seconds, decant the turbid water into an earthen or wooden vessel. By this process the earth will be separated from the sand and other foreign bodies, which are precipitated, and which must be thrown away. If washed by the same process on a large scale, it is divided by kneading it. The supernatant water is thrown aside, and the sediment placed in sieves on pieces of cloth, where it drains; it is then mixed up with oil rendered drying, by a large dose of litharge, about a fourth of the weight of the oil. The consistence of thin paste being given to the mixture, it is spread over the cloth, by means of an iron spatula, the length of which is equal to the breadth of the cloth. The spatula performs the part of a knife, and pushes forward the excess of matter, above the quantity sufficient to cover the cloth. The inequalities of the cloth

produced by its coarseness, are smoothed down by pumice stone. The stone is reduced to powder, and rubbed over the cloth with a piece of soft serge or cork dipped in water. The cloth must then be well washed in water to clean it; and after it is dried a varnish of gum lac dissolved in linseed oil boiled with turpentine must be applied to it. This preparation produces yellowish varnished cloth. When wanted black, mix lampblack with the Spanish white, or tobacco pipe clay, which forms the basis of the liquid paste; various shades may be obtained according to the quantity of the lampblack which is added. Umber, Cologne earth, &c. may be used to vary the tints, without causing any addition to the expense.

*To prepare fine Printed Varnished Cloth.* The process above described may serve to give some idea of that employed for making fine cloths of the same kind, decorated with a coloured impression. The manufactories of Germany have varnished cloths embellished with large and small subjects, figures and landscapes, well executed, and which are destined for covering furniture subject to daily use.

This process, which is only an improvement of the former, requires a finer paste, and cloth of a more delicate texture: the stratum of paste is applied in the same manner, and when dry and polished, the cloth is taken from the frame, and removed to the painter's table, where the art of the colourist and designer is displayed under a thousand forms, and as that in printed cottons, exhibits a richness of tints and a distribution of subjects, which discover taste, and ensure a ready sale for the article manufactured. The processes, however, employed in these two arts, to extract the colouring parts, are not the same. In the art of cotton printing, the colours are extracted by the bath, as in that of dying. In printing varnished cloths, the colouring parts are the result of the union of drying oil, mixed with varnish; and the different colours employed in oil painting and painting in varnish. The varnish applied to common oil cloth is composed of gum lac and drying linseed oil; but that destined for printed varnished cloths requires some choice, both in regard to the oil and the resinous matter which gives it consistence. Prepared oil of pinks and copal form a varnish very little coloured, pliable and solid.

*To prepare Varnished Silk.* 1. Varnished silk for umbrellas, &c. is prepared in the same manner as the cloths al-

ready described ; but with some variation in the paste or varnish.

The cloth is placēd on a frame as before described ; a soft paste composed of linseed oil, boiled with a fourth part litharge ; tobacco pipe clay, dried and sifted through a silk sieve, sixteen parts, litharge, ground on porphyry with water, dried and sifted in the same manner, three parts, and lampblack, one part. This paste is then spread in an uniform manner over the surface of the silk by means of a long knife, having a handle at the extremity. In summer, twenty-four hours are sufficient for its desiccation. When dry, the knots produced by the inequalities of the silk, are smoothed by a pumice stone. This operation is performed with water. When finished, the surface of the silk is washed ; when dry, fat copal varnish is applied.

If it is intended to polish the varnish, apply a second stratum ; after which polish it with a ball of cloth and very fine Tripoli. The varnished silk, thus made is very black, exceedingly pliable, and has a fine polish.

2. A kind of varnished silk which has only a yellowish colour, and which suffers the texture of the stuff to appear, is prepared with a mixture of three parts boiled oil of pinks, and one part fat copal varnish, which is extended with a coarse brush or a knife. Two strata are sufficient when oil has been freed from its greasy particles over a slow fire, or when boiled with a fourth part of its weight of litharge.

The inequalities are removed by pumice stone and water, after which the copal varnish is applied.

*To recover Varnish.* Clean off the filth with a lye made of potash, and the ashes of lees of wine ; then take forty-eight ounces of potash, and sixteen of the above mentioned ashes, and put them into six quarts of water, and this completes the lye.

*To polish Varnish.* This is effected with pumice stone and Tripoli earth. Reduce the pumice stone to an impalpable powder, and put it upon a piece of serge moistened with water ; with this rub lightly and equally the varnished substances. The Tripoli must also be reduced to a fine powder, and put upon a clean woollen cloth, moistened with olive oil, with which the polishing is to be performed. The varnish then is to be wiped off with soft linen, and when quite dry, cleansed with starch, or Spanish white, and rubbed with the palm of the hand.

*Amber Varnish with Essence Turpentine.* Six or seven ounces of liquefied amber, and separated from the oily portions which alter its consistence. Reduce the amber to powder, and if the operation of pounding forms it into a paste, break it with your fingers; then mix it with the essence, and heat the whole in a *balneum mariæ*. It will speedily dissolve, and the essence will take up, at least, a fourth part of its weight of the prepared amber. When one coating of it is applied to white smooth wood, but without any preparation, it forms a very pure and durable glazing, which speedily dries, but slower than copal varnish.

*Ethereal Copal Varnish.* Half an ounce of ambery copal and two ounces of ether. Reduce the copal to a very fine powder, and introduce it by small portions into the flask which contains the ether; close the flask with a glass or cork stopper, and having shaken the mixture for half an hour, let it rest till the next morning. In shaking the flask, if the sides become covered with small undulations, and if the liquor be not exceedingly clear, the solution is not complete. In this case, add a little ether, and leave the mixture at rest. The varnish is of a light lemon colour. The largest quantity of copal united to ether, may be a fourth, and at least a fifth. The use of copal varnish made with ether, seems, by the expense attending it, to be confined to repairing those accidents which frequently happen to the enamel of toys, as it will supply the place of glass to the coloured varnishes, employed for mending fractures, or to restoring the smooth surface of paintings which have been cracked and shattered. The great volatility of ether, and in particular its high price, do not allow the application of this varnish to be recommended, but for the purpose here indicated. It has been applied to wood with complete success, and the glazing it produced, united lustre to solidity. In consequence of the too speedy evaporation of the liquid, it often boils under the brush. Its evaporation, however, may be retarded, by spreading over the wood a slight stratum of essential oil of rosemary or lavender, or even of turpentine, which may afterwards be removed by a piece of linen rag; what remains is sufficient to retard the ether.

*Turpentine Copal Varnish.* One and a half ounces copal, of an amber colour, and in powder, and eight ounces of the best oil of turpentine. Expose the essence to a *balneum*

mariaë, in a wide mouthed matrass, with a short neck; as soon as the water of the bath begins to boil, throw into the essence a large pinch of copal powder, and keep the matrass in a circular motion. When the powder is incorporated with the essence, add new doses of it; and continue in this manner till you observe there is formed an insoluble deposite. Then take the matrass from the bath, and leave it at rest for some days. Draw off the clear varnish, and filter it through cotton. At the moment when the portion of the copal is thrown into the essence, if the powder precipitates itself under the form of lumps, it is needless to proceed any further. This effect arises from two causes; either the essence does not contain the proper degree of concentration, or it has not been sufficiently deprived of water. Exposure to the sun, employing the same matrass to which a cork stopper ought to be added, will give it the qualities requisite for the solution of the copal. This effect will be announced by the disappearance of the portion of copal already put into it.

-2. Three ounces of copal liquefied, and twenty ounces essence of turpentine. Place the matrass containing the oil in a balneum mariaë, and when the water boils, add the pulverized copal in small doses. Keep stirring the mixture, and add no more copal till the former is incorporated with the oil. If the oil, in consequence of its particular disposition can take up three ounces of it, add a little more; but stop if the liquid becomes nebulous, then leave the varnish at rest. If it be too thick, dilute it with a little warm essence after having heated it in the balneum mariaë. When cold, filter it through cotton, and preserve it in a bottle. This varnish has a good consistence, and is as free from colour as the best alcohol varnish. When extended in one stratum over smooth wood, which has undergone no preparation, it forms a very brilliant glazing, which, in the course of two days, in summer, acquires all the solidity that may be required.

The facility which attends the preparation of this varnish, by the new method here indicated, will admit of its being applied to all coloured grounds which require solidity, pure whites alone excepted; painted boxes, therefore, and all small articles, coloured or otherwise, whenever it is required to make the veins appear in all the richness of their tones, call for the application of this varnish, which produces a most beautiful effect, and which is more durable than turpentine varnishes with other resinous substances.

*Varnish for Watch Cases in imitation of Tortoise Shell,*

**Six ounces copal**, of an amber colour, one and a half ounces Venice turpentine, twenty-four ounces prepared linseed oil, and six ounces essence of turpentine. It is customary to place the turpentine over the copal, reduced to small fragments, in the bottom of an earthen or metal vessel, or in a matrass exposed to such a heat as to liquefy the copal; but it is more advantageous to liquefy the latter alone, to add the oil in a state of ebullition, then the turpentine liquefied, and in the last place the essence. If the varnish is too thick, some essence may be added. The latter liquor is a regulator for the consistence in the hands of an artist.

*Resinous Drying Oil.* Ten pounds of drying nut oil, if the paint is destined for external, or ten pounds drying linseed oil, if for internal articles. Three pounds of resin, and six ounces of turpentine. Cause the resin to dissolve in the oil by means of a gentle heat. When dissolved and incorporated with the oil, add the turpentine; leave the varnish at rest, by which means it will often deposit portions of resin and other impurities; and then preserve it in wide mouthed bottles. It must be used fresh; when suffered to grow old, it abandons some of its resin. If this resinous oil assumes too much consistence, dilute it with a little essence, if intended for articles sheltered from the sun, or with oil of poppies.

In Switzerland, where the principal part of the mason's work consists of stones subject to crumble to pieces, it is often found necessary to give them a coating of oil paint, to stop the effect of this decomposition. This painting has a great deal of lustre, and when the last coating is applied with resinous oil, it has the effect of varnish. To give it more durability, the first ought to be applied exceedingly warm, and with plain oil, or oil very little charged with the grey colour which is added to fat copal varnish and the varnish to watch cases, &c.

*Fat Copal Varnish.* Sixteen ounces picked copal, eight ounces prepared linseed oil, or oil of poppies, and sixteen ounces turpentine. Liquefy the copal in a matrass over a common fire, and then add the linseed oil, or oil of poppies, in a state of ebullition; when these matters are incorporated, take the matrass from the fire, stir the matter till the greatest heat has subsided, and then add the essence of turpentine when warm. Strain the whole, while still warm, through a piece of linen, and put the varnish into a wide mouthed bottle. Time contributes towards its clarification; and in this manner it acquires a better quality.

*To give a drying quality to Fat Oil.* Eight pounds nut



or linseed oil, one ounce white lead, slightly calcined, one ounce yellow acetate of lead, (sal saturni) also calcined, one ounce sulphate of zinc, (white vitriol) twelve ounces vitreous oxide of lead, (litharge) and a head of garlic or a small onion. When the dry substances are pulverized, mix them with the garlic and oil, over a fire capable of maintaining the oil in a slight state of ebullition; continue it until the oil ceases to throw up scum, till it assumes a reddish colour, and till the head of the garlic becomes brown. A pellicle will then be soon formed on the oil, which indicates that the operation is completed. Take the vessel from the fire, and the pellicle, being precipitated by rest, will carry with it all the unctuous parts which rendered the oil fat. When the oil becomes clear, separate it from the deposite, and put it into wide mouthed bottles, where it will completely clarify itself in time and improve in quality.

2. One and a half ounces vitreous oxide of lead, 3-8 of an ounce sulphate of zinc, and sixteen ounces linseed or nut oil. This operation must be conducted as in the preceding case. The choice of the oil is not a matter of indifference. If it be destined for painting articles exposed to the impression of the external air, or for more delicate painting, nut oil or poppy oil will be required. Linseed oil is used for coarse painting, and that sheltered from the effects of the rain and the sun. A little negligence in the management of the fire, has often an influence on the colour of the oil, to which a drying quality is communicated; in this case it is not proper for delicate painting.

This inconvenience may be avoided by tying up the drying matters in a small bag: but the dose of litharge must then be doubled. The bag must then be suspended by a piece of packthread; fastened to a stick, which is made to rest on the edge of the vessel in such a manner as to keep the bag at the distance of an inch from the bottom of the vessel. A pellicle will be formed, as in the first operation, but it will be slower in making its appearance.

3. A drying quality may be communicated to oil by treating, in a heat capable of maintaining a slight ebullition, linseed or nut oil, to each pound of which is added three ounces of vitreous oxide of lead, reduced to fine powder. The preparation of floor cloth, and all paintings of large figures or ornaments, in which argillaceous colours, such as yellow and

red boles, Dutch pink, &c. are employed, require this kind of preparation, that the desiccation may not be too slow; but painting for which metallic oxides are used, such as preparations of lead, copper, &c. require only the doses before indicated; because these oxides contain a great deal of oxygen, and the oil by their contact, acquires more of a drying quality.

4. Two pounds of nut oil, three pounds common water, and two ounces sulphate of zinc. Mix these matters and subject them to a slight ebullition, until little water remains. Decant the oil, which will pass over with a small quantity of water, and separate the latter, by a funnel. The oil remains nebulous for some time, after which it becomes clear, and seems to be very little coloured.

5. Six pounds nut or linseed oil, four pounds common water, one ounce sulphate of zinc and one head of garlic or a small onion. Mix these matters in a common iron or copper pan, then place them over the fire, and maintain the mixture in a state of ebullition during the whole day; boiling water must be added from time to time, to make up the loss from that by evaporation. The garlic will assume a brown appearance, Take the pan from the fire, and having suffered a deposite to be formed, decant the oil, which will clarify itself in the vessels; by this process the drying oil is rendered somewhat more coloured; it is reserved for delicate colours.

*To give a drying quality to Poppy Oil.* Three pounds of pure water, one ounce of sulphate of zinc, two pounds oil of pinks, or poppy oil. Expose this mixture in an earthen vessel, capable of standing the fire, to a degree of heat sufficient to maintain it in a slight state of ebullition. When one half or two-thirds of the water has evaporated; pour the whole into a large glass bottle or jar, and let it rest, till the oil becomes clear. Decant the clearest part by means of a glass funnel, the beak of which is stopped with a piece of cork. When the separation of the oil from the water is completely effected, remove the cork stopper, and supply its place by the fore finger, which must be applied in such a manner as to suffer the water to escape, and to retain only the oil. Poppy oil when prepared in this manner, becomes after some weeks exceedingly limpid and colourless.

*To make Varnish for Silk, &c.* To one quart of cold

drawn linseed oil, poured off from the lees, (produced on the addition of unslacked lime, on which the oil has stood eight or ten days at the least, in order to communicate a drying quality, or brown umber burnt and powdered which will have the like effect,) and half an ounce of litharge; boil them for half an hour, then add half an ounce copal varnish. While the ingredients are on the fire in a copper vessel, put in one ounce Chios turpentine, or common resin, and a few drops neat's foot oil, and stir the whole with a knife; when cool, it is ready for use. The neat's foot oil prevents the varnish from being sticky or adhesive, and may be put into linseed oil at the same time with the lime, or burnt umber. Resin or Chios turpentine may be added, till the varnish has attained the desired thickness.

The longer the raw linseed oil remains on the unslacked lime or umber, the sooner will the oil dry after it is used; if some months so much the better; such varnish will set, that is to say not run, but keep its place on the silk in four hours; the stick may then be turned, and varnished on the other side.

*To make pliable Varnish for Umbrellas.* Take any quantity of caoutchouc, as ten or twelve ounces, cut into small bits, and put into a ladle, such as plumbers, glaziers, &c. melt their lead in, over a common pit coal or other fire, which must be gentle, glowing, and without smoke. When the ladle is hot, put a single bit into it; if black smoke issues, it will flame and disappear, or it will evaporate without flame; the ladle is then too hot. When the the ladle is less hot, put in a second bit, which will produce a white smoke; this white smoke will continue during the operation, and evaporate the caoutchouc; therefore, no time is to be lost, but little bits are to be put in, a few at a time, till the whole are melted; it should be continually and gently stirred with an iron or brass spoon. The instant the smoke changes from white to black, take off the ladle, or the whole will break out into a violent flame, or be spoiled, or lost. Care must be taken that no water is added, a few drops of which, on account of its expansibility, makes it boil over furiously and with a great noise; at this period of the process, one quart of the best drying oil is to be put into the melted cautechoue, and stirred till hot, and the whole poured into a glazed vessel through a coarse gauze, or wire sieve. When settled and clear, which will be in a few minutes, it is fit for use. The silk should at-

ways be stretched horizontally by pins or tenter hooks on frames, and the varnish poured on cold in hot weather, and hot if cold weather. The art of laying it on properly, consists in making no intense motion in the varnish, which would create minute bubbles, therefore, brushes of every kind are improper, as each bubble breaks in drying, and forms a small hole; through which the air will transpire. This varnish is pliant, unadhesive, and unalterable by weather.

*Transparent Japan for Tin Ware.* Oil of turpentine, eight ounces, oil of lavender, six ounces copal, two ounces, camphor, one drachm.

*Drying Oil.* Linseed oil, two pints, litharge or ceruse, one ounce; dissolve with heat; added to paints to make them dry sooner.

*Le Blond's Varnish for Prints.* Balsam copaiva four pounds, copal in powder, one pound; add by single ounces every day to the balsam, keeping it in a warm place, or in the sun, stirring it frequently; when all is dissolved, add Chios turpentine, q. p.

*Sheldrake's Copal Varnish.* Oil turpentine, ret. veri: one pint, sal ammoniac two ounces: mix; add copal in small pieces, two ounces; stop the vessel with a cork cut in grooves; bring it quickly to boil, that the bubbles may be counted as they rise; and keep it at that; if the least stoppage or overheating takes place, it is in vain to proceed. Then leave the vessel till quite cold, before you open it; otherwise the varnish will be thrown out with violence.

*Sheldrake's Oil for Painting.* Nut or poppy oil, one pint, boil; add ceruse, two ounces, when dissolved, add a pint of copal varnish, previously warmed, and stir it till the oil of turpentine is evaporated; gives more brightness than common drying oil, but less than varnish only; loses its dry quality in time, therefore, only so much as is sufficient for a month or six weeks' consumption should be prepared at once.

*Varnish to be laid on Gilding and Silvering.* Grind verdigris, on marble with common water, in which saffron has been infused for eight hours.

*A Common Varnish.* Sandarac eight ounces, tereb. Venit: six ounces, spirits wine, rectified, two pints.

*White Varnish.* Gum juniper, one pound, Strasburg turpentine, six ounces, spirits wine, rectified, two pints, used upon paper, wood, and linen.

**White Hard Varnish.** Mastic, four ounces, gum juniper, tereb. Venit. of each three ounces (to prevent the gums forming an impenetrable mass,) add four ounces pounded glass, spirits wine rectified, two pints, used upon cards, sheaths, &c.

**White Polishing Varnish.** Mastic in tears, two ounces, gum juniper, eight ounces, gum elemi, one ounce, tereb. argent. four ounces, spirits wine rectified, two pints; used upon metals, polished with pumice stone.

**Transparent Copal Varnish.** Spirits wine fully charged with camphor, four ounces, copal in fine powder, one ounce; dissolve, filter; add the filtered liquor to spirits of wine, one part, in which gum elemi one ounce, has been previously dissolved.

2. Spirits wine rectified, one pint, camphor, half an ounce; dissolve; pour it upon copal in small pieces, four ounces; heat it so that the bubbles which rise may be counted; when cold, pour it off and add more spirits to the residuum: used for pictures.

3. Copal, melted and poured into water, three ounces, gum sandarac six ounces, mastic three ounces, tereb. argent. two ounces and a half, pounded glass, four ounces, spirits wine rectified, two pints; used for metals, chairs, &c.

**Soft Brilliant Varnish.** Gum sandarac, six ounces, gum elemi, four ounces, camphor, four drachms, spirits wine rectified, two pints; used upon wood work and pasteboard.

**Reddish Varnish.** Gum sandarac, eight ounces, lava in tabulis, two ounces, resina nigri, four ounces, tereb. Venit. six ounces, spirits wine rectified, two pints; used on wood and metals.

**Red Varnish.** Sandarac, four ounces, seed-lac, two ounces, mastic, choice Benjamin, of each one ounce; turpentine two ounces, spirits wine rectified two pints; used for violins and cabinet work.

**Nut Oil.** From the kernel of the hazel nut, very fine; substituted for oil of Benjamin, as it will keep better than that of almonds; it has been proposed in the college lists, to be substituted for that oil, being nearly equal to it; is drank with tea in China, probably in lieu of cream; used by painters as a superior article for their colours.

**Hemp Oil.** From hemp seed, used by painters as a drying oil.

*Walnut Oil.* Makes good plasters, but will not keep; used by painters; is very drying; they yield about half their weight of oil.

*Picture Varnish.* Mastic twelve ounces, Venit. turpentine, two ounces four drachms, camphor, thirty grains, pounded glass, four ounces, oil turpentine, three pints and a half; pour off the clear; used to oil paintings.

*Gold Varnish for Leather.* Tumeric, gamboge, of each one scruple and a half, oil turpentine two pints; add seed-lac, gum sandarac, of each four ounces, dragon's blood four drachms, Venit. turpentine, two ounces, pounded glass, four ounces; pour off the clear.

*Copal Varnish.* Oil turpentine, thickened by keeping, eight ounces, copal, two ounces and a half.

2. Oil turpentine, six ounces, oil lavender, two ounces, copal, one ounce.

*Common Turpentine Varnish.* Resin flav. three pounds, eight ounces, oil terebinth. one gallon.

*Varnish for Coloured Drawings.* Canada balsam, one ounce, oil turpentine two ounces: size the drawing first with a jelly of isinglass, and when dry, apply the varnish; which will make them resemble oil paintings.

*Black Japan Leather.* Boiled linseed oil, one gallon, burnt umber eight ounces, asphaltum, three ounces, boil and add oil terebinth. q. s.

This varnish perhaps is the best in use for iron—for which purpose the oil should be reduced by boiling with a well directed heat, one half. The umber should be finely pulverised on porphyry (a kind of red and white marble, such as painters generally use) and put into the oil, before boiling and add the other ingredients, when nearly cool, after boiling—when asphaltum (or mineral tar) cannot be procured, for one gallon of linseed, put into the spirits of turpentine, a paper of lampblack which after having stood a few hours should be strained through coarse flannel and then blended, with the oil after having been boiled and cooled, as before, directed—for a polishing varnish add to the oil, when at its boiling point a quarter of a pound of Gum Shellac—this also furnishes a brilliant coating for iron—particularly for rough castings; but the asphaltum, renders it more durable; in boiling oil in every case great care is requisite to prevent its burning; and in general varnishes would be infinitely better, to boil the oil to the consistence of one half or nearly.

*Scouring Drops.* Oil terebinth. sented with essence lemon.

*Furniture Oil.* Oil lini, coloured with rad anchusæ,

*Furniture Varnish.* White wax, eight ounces, oil terebinth. one pint.

*Bronzing Liquor.* It is blue vitriol, dissolved in water; used to bronze tea urns, &c. the surface being previously well cleaned.

*Blue or Green Sympathetic Ink.* Drop a tea spoonful of zaffre into a third of a wine glass of nitro-muriatic acid. After standing awhile, write on paper; the writing will be blue, unless there is a little iron in the zaffre, which will give it a green hue. If a little common salt in solution had been added, the writing would disappear on removing from the fire.

*Invisible Ink.* Whittle off a little bismuth into a wine glass. Drop in a little common nitric acid diluted with half as much water. Violent action will commence; when it ceases the nitrate will be formed in the liquid state. Dip a clean pen into it and write as with ink; hold the paper near a fire, but not so near as to heat it, the letters will become invisible; now dip it into water or hold it in a steam over boiling water, and on taking it out, the letters will become visible, and appear as if written with pale ink.

After a short time the writing will disappear and leave not a vestige to prove a forgotten promise.

*Callot's Varnish.* Two ounces finest linseed oil, Benjamin in drops, two drachms, white wax the bulk of a filbert, boil all together, till it is reduced to one-third, stirring it constantly. When done, put it into a large mouthed phial. Warm the plate intended to be engraven, and for which this varnish is designed, and with the finger pass it over the place, leaving it slightly coated, and smooth; after which smoke the plate on the varnished side, with a candle, until it is black in every part. Place the plate over a chafing dish, with charcoal fire, and when it has done fuming, the varnish has become sufficiently hardened, when it is prepared to chalk, draw and etch, whatever is desired. This varnish was used by Callot, to engrave his most admired subjects.

*To colour Foils.* For colouring foils two methods have been invented. The first by tinging the surface of the copper with the colour required, by means of smokes, the other by staining or painting it with some pigment, or other colouring substance. The colours used for painting foils may be tempered with either oil, water rendered duly viscid by gum

Arabic, size, or vanish. If deep colours are wanted, oil is most proper, as some pigments become wholly transparent in it, as lake or Prussian blue; the yellow and green may be laid on in varnish, as these colours may be had in perfection, from a tinge wholly dissolved in spirit of wine, in the same manner as in the case of lacquers; and the most beautiful green is to be produced by distilled verdigris, which is apt to lose its colour and turn black with oil. In common cases, any of the colours may be laid on with the least trouble, in the same manner as the glazing colours used in miniature painting.

*Ruby Colours.* For red, where the ruby is to be imitated, a little lake is used with isinglass size; carmine, or shell-lac varnish, should be used if the glass or paste, is of a full crimson, verging towards the purple; but if the glass incline to the scarlet or orange, very bright lake, that is, not purple, may be used alone in oil.

*Garnet Red.* Dragon's blood dissolved in seed-lac varnish, may be used; for the vinegar garnet, the orange lake tempered with shell-lac varnish will be found excellent.

*Amethyst.* Lake, with a little Prussian blue, used with oil, and thinly spread on the foil.

*Blue.* When a deep colour or the effect of the sapphire is wanted, Prussian blue, that is not too deep, used in oil, and spread more or less thinly on the foil, according to the lightness or deepness of the colour required.

*Eagle Marine.* Common verdigris, with a little Prussian blue, tempered in shall-lac varnish.

*Yellow.* Colour the foil with a yellow lacquer; if a full yellow is desired, lay it on as for other purposes. For the slighter colour of topazes, the burnish and foil itself will be sufficiently strong without any addition.

*Green.* If a deep hue is required, the crystals of verdigris, tempered in shell-lac should be used. But if the emerald is to be imitated, a little yellow lacquer should be added, to produce a truer green, less verging to the blue.

*Other Colours.* Stones of more diluted colour, such as the amethyst, topaz, vinegar garnet, &c. may be very cheaply imitated by transparent white glass or paste, even without foils. This is done by tempering the colours above enumerated with turpentine and mastic, and painting the socket in which the counterfeit stone is to be set with the mixture, the socket and stone being previously heated. The stone should



be immediately set, and the socket closed upon it before the mixture cools and grows hard. The orange lake was invented for this purpose. The colour it produces is that of the vinegar garnet, and has been used with great success by a manufacturer. The colour before directed to be used in oil should be extremely well ground in oil of turpentine, and tempered with old nut or poppy oil; or, if time can be given to dry, with strong fat oil diluted with spirits of turpentine, which gives a fine polish of itself. The colours used in varnish, should also be well ground and mixed—when dragon's blood in the seed-lac varnish and the lacquer, the foils should be warmed before they are laid out. All the mixtures should be laid on the foil with a broad soft brush, passed from one end to the other; no part crossed or gone over twice, or at least, until the first coat is dry. When the colours are not strong enough another coat may be given.

*Lacquer for Brass.* Six ounces of seed-lac, two ounces of amber or copal, ground on porphyry forty grains dragon's blood, thirty grains extract of red sandal wood, obtained by water, thirty-six grains oriental saffron, four ounces pounded glass, and forty ounces very pure alcohol.

To apply this varnish to articles or ornaments of brass, expose them to a gentle heat, and dip them into varnish. Two or three coatings may be applied in this manner, if necessary. The varnish is durable, and has a beautiful colour. Articles varnished in this manner, may be cleaned with water, and a bit of dry rag.

*Lacquer for Philosophical Instruments.* This lacquer is destined to change, or to modify the colour of those bodies to which it is applied. Three-fourths of an ounce of gum guttæ, two ounces of gum sandarac, two ounces of gum elemi, one ounce of dragon's blood, opt. one ounce of seed lac, three-fourths of an ounce terra merita, two grains oriental saffron, three ounces of pounded glass, and twenty ounces of pure alcohol. The tincture of saffron and terra merita, is first obtained by infusing them in alcohol for twenty-four hours, or exposing them to the heat of the sun in summer. The tincture must be strained through a piece of clean linen cloth, and ought to be strongly squeezed. This tincture is poured over the articles which do not compose tincture, all pounded and mixed with the glass. The varnish is then made according to the directions before given. It may be applied

with great advantage to philosophical instruments: the use of it might be extended also, to various, or moulded articles with which furniture is ornamented. If the dragon's blood be of the best quality, it may give too high a colour; in this case the dose may be lessened at pleasure, as well as that of the other colouring matters.

It is with similar varnish that the artists of Geneva, give a golden orange colour, produced by certain compositions, the preparation of which has no relation to that of varnish, and which has been successfully imitated by saline mixtures, in which orpiment is a principal ingredient. The nails are heated before they are immersed in the varnish, and they are then spread out on sheets of dry paper.

*Gold Coloured Lacquer for Brass Watch Cases, Watch Keys, &c.* Six ounces of seed-lac, two ounces of amber, two ounces of gum guttæ, twenty-four grains extract of red sandal wood in water, sixty grains of dragon's blood, thirty-six grains of oriental saffron, four ounces of pounded glass and thirty-six ounces of pure alcohol, grind the three first articles and the dragon's blood on a piece of porphyry; then mix them with the pounded glass, and add the alcohol, after forming it with an infusion of the saffron, and the extract of the sandal wood. The varnish must be completed as before. The metal articles destined to be covered by this varnish, are heated, and those which will admit of it are immersed in packets. The tint of the varnish may be varied, by modifying the doses of the colouring substances.

*Lacquer of a less drying quality.* Four ounces of seed-lac, four ounces of sandarac or mastic, one-half an ounce of dragon's blood, thirty-six grains of terra merita, thirty-six grains of gum guttæ, three ounces of pounded glass, two ounces of clear turpentine, thirty-two ounces of essence of turpentine.

Extract by infusion the tincture of the colouring substances, and then add the resinous bodies according to the directions for compound mastic varnish. Lacquer or varnishes of this kind are called changing, because, when applied to metals, such as copper, brass, or hammered tin, or to wooden boxes and other furniture, they communicate to them a more agreeable colour. Besides, by their contact with the common metals, they acquire a lustre which approaches that of the precious metals, and to which, in consequence of peculiar intrinsic qualities or certain laws of convention, a much greater

value is attached. It is by means of these changing varnishes, that artists are able to communicate to their leaves of silver and copper, those shining colours observed in foils. The product of industry becomes a source of prosperity to the manufacturers of buttons and works formed with foils, which in the hands of the jeweller, contributes with so much success to produce that reflection of the rays of the light, which doubles the lustre and sparkling quantity of precious stones.

It is to varnish of this kind that we are indebted for the manufacture of gilt leather, which, taking refuge in England, has given place to that of papier mache, which is employed for the decoration of palaces, theatres, &c.

In the last place it is by the effect of a foreign tint obtained from the colouring part of saffron, that the scales of silver disseminated in *confection de hyacinth*, reflect a beautiful gold colour. The colours transmitted by different colouring substances, require tones suited to the objects for which they are destined. The artist has it in his own power to vary them at pleasure. The addition of arnotto to the mixture of dragon's blood, saffron, &c. or some changes in the doses of the mode intended to be made in colours. It is therefore impossible to give limited formulæ.

*To made Lacquer of various Tints.* Four ounces gum guttæ in thirty-two ounces of essence of turpentine, one ounce arnotto, and four ounces dragon's blood; also in separate doses of essence.

These infusions may be easily made in the sun. After fifteen days exposure, pour a certain quantity of these liquors into a flask, and by varying the doses, different shades of colours will be obtained. These infusions may also be employed for changing alcoholic varnishes; but in this case, the use of saffron, as well as that of red sandal wood, which does not succeed with essence, will soon give the tone necessary for imitating, with other tinctures, the colour of gold.

*To brown Gun-Barrels.* After the barrel is finished, rub it over with aqua-fortis, or spirit of salt diluted with water, then lay it by for a week, till a complete coat of rust is formed. A little oil is then to be applied, and after rubbing the surface dry, polish it with a hard brush and a little beeswax.

## CHAPTER XXIX.

*Glue, Pastes, &c.*

Glue is made in Europe, of ears, feet, trimmings, sinews and scrapings of the skins of oxen, calves, sheep, &c. old leather, and fresh or raw hides mixed and manufactured together; and this mixture is said to yield one third of its weight in good strong glue. The best glue is from the hides of old animals; whole skins are seldom used, unless they are injured by the worm, rotted, or otherwise rendered unfit to make leather; but the smallest pieces are saved for that purpose. In making glue of fresh pieces of skin, let them be steeped in water for two or three days; dried hides may require longer time; and bits of leather much longer. While soaking they should be stirred occasionally, then put them to drain in hand barrows, with grated bottoms, or in boxes with sloping sides and grated bottoms; when drained let them be well washed in several waters. The ears and other dirty parts should be steeped and washed by themselves; after they are washed clean, put them in a weak limewater, in iron hooped tubs. Leather will require to be kept in weak limewater a considerable time, and a little fresh lime should be added occasionally; alumed skins, tallowed, greasy, bloody, or hairy skins, should be put into a stronger limewater, and kept longer in it. They sometimes require to be taken out, so as to permit the lime to dry on them, and to remain for a considerable time; after which they must be soaked and well stirred; then press them out as dry as possible, and put them in a copper kettle for boiling, at the bottom of which kettle should be a wooden grate. The copper should be filled with the material pressed close, and as much water poured on as will run among the pieces: make a moderate fire, which increase by degrees till it boils. As the materials melt into glue, some decrease the fire without stirring them, others stir them as they dissolve. When the glue, on cooling, forms a pretty thick jelly, it is done: after this a box is made with wooden gratings for the bottom; the inside of the grating bottom is to be lined with horsehair cloth, and the box to be placed over a large tub. The glue is to be passed through the horsehair cloth, or strainer, quickly, while it is very hot. The dregs are left to drain some time, and are called by the workmen glue-dreg; they make an excellent fuel mixed with

wood. The room should be kept warm while the glue is settling. In the tubs there should be cocks to draw off the hot liquid glue: the first glue will be the brightest; but the last will be equally good. Through the cocks it must run into flat moulds, previously wet. When cool, cut it out with a wet knife into squares; and hang it on a line to dry and harden in a draught of air;—some place it on a net hung on four posts, turning it occasionally: ten days of dry weather, or fifteen days of wet (under cover) are required in Europe, but less time in America. To polish the cakes, wet them and rub them with new lime. The best glue has few dark spots, and no bad smell; and shines when broken. To try glue, put it into cool water for three or four days, where it must not dissolve, but when dried must preserve its weight.

The time of boiling is from twelve to fifteen hours, according to the fire. Violent heat is to be avoided.

2. If bones are digested for seven or eight days, with weak hydrochloric acid, this acid dissolves all the salts that enter into their composition; the bones are softened, become very flexible; and at length contain only animal matter. If, in this state, they are put for some moments into boiling water, and after wiping them dry they are subjected to a stream of cold and fresh water, they may be regarded as pure gelatin; or at least, as a substance, which, being dissolved in boiling water, affords the handsomest size.

In order to prepare glue from the clippings of skins of parchment, or gloves; from the hoofs, the ears of oxen; horses, sheep, calves, &c. after taking off the hair and removing the fat from these substances, we boil them for a long time in a large quantity of water; the scum is separated, its formation being favoured by adding a little alum or lime; the liquor is strained, and suffered to rest; it is then poured off, and skimmed again; and then heated to concentrate it. When sufficiently so, it is poured into moulds previously wetted; where, by cooling, it forms into soft plates; which at the end of twenty-four hours, are cut into tablets, and dried in a warm and airy situation.

*A very strong Glue.* Soak the finest isinglass twenty-four hours in spirits of wine or strong brandy, then boil all very gently together, continually stirring it, that it may not burn, until it becomes one liquor. Then strain it while hot through a coarse linen cloth into a vessel, when it should be close stopped; a gentle heat will melt this glue to use.

*A Parchment Glue.* Put two or three pounds of scrapings or cuttings of parchment into a bucket of water, boil the whole till it be reduced to half, pass it through an open linen, and then let the liquor cool, when it will be a parchment glue.

*A Strong Paste.* Common paste is made of wheat flour boiled in water, till it be of a viscid consistence, but when used by book binders and paper hangers, it is requisite to mix a fourth, fifth, or sixth of the weight of flour of powdered resin or rosin; and when it is wanted still more tenacious, gum Arabic, or any kind of size may be added. In order to prevent the paste used in papering rooms, &c. from being gnawed by rats &c. powdered glass is sometimes mixed with it; but the most effectual and easy remedy is to dissolve a little sublimate say one drachm to a water, which not only prevents rats and mice, but all kinds of vermin being troublesome.

*Of Fibrin.* If blood is agitated with a handful of rods, immediately after having been drawn from the veins, the fibrin adheres to them; it is then only necessary to wash it repeatedly, in order to discolour it and obtain it pure.

*Liquid Albumen.* This constitutes the white of the egg; in truth this last, besides albumen, contains several salts, and some sub-carbonate of soda, of which it is impossible to divest it.

*Solid Albumen.* Pour alcohol on the white of an egg, dissolved in water, and filtered; the albumen immediately precipitates, and is to be washed.

*Fish Glue—Isinglass.* To procure this, the inner membrane of the *swimming bladders* of some kinds of sturgeon are washed; they are then slightly dried and rolled and afterwards dried in the air. An inferior kind is prepared by digesting in boiling water, the head, the tail, and the jaws of certain whales, and almost all fish without scales.

*Potatoe Starch—common Arrow Root:* may be made from frozen potatoes in as large a quantity and as good, as those which have not been spoiled by the frost; very white, crimp to the fingers, and colours them; friable, heavy, sinking in water; when held to the light, it has shining particles in it: dissolves in boiling water as easily as the true arrow root: 100 pounds of potatoes yield 10 pounds of starch.

## CHAPTER XXV.

*The Art of Dying—Cotton—Linen—Wool—Silk—Wool-  
len Goods—Mordants—Effects of Salts on Mordants—to  
render Colours holding—Solution of Tin in Aqua-Regia  
—Muriate of Tin—Acetate of Alumine—Effects of va-  
rious Waters on different Colours—to Re-dye or change  
Colours—Drying Bath—Sulphate of Arsenic—to Dye  
Compound Colours—to Dye Straw and Chip Bonnets—  
Basis for many Colours.*

DYING is a chemical process, and consists in combining a certain colouring matter with fibres of cloth. The facility with which cloth imbibes a dye, depends upon two circumstances; the union of the cloth and the dyestuff or dying material, and the fluid in which it is dissolved. Wool unites with almost all colouring matters, silk in the next degree, cotton considerably less, and linen the least of all. To dye cotton or linen, the dyestuff or colouring material, should, in many cases, be dissolved in a substance for which it has a weaker connexion, than with the solvent employed in the dying of wool or silk. Thus we may use the colour called oxide of iron, dissolved in sulphuric acid, to die wool; but to dye cotton and linen, it is necessary to dissolve it in acetic acid. Were it possible to procure a sufficient number of colouring substances, having a strong affinity for cloths, to answer all the purpose the art of dying would be extremely simple and easy. But this is by no means the case. This difficulty has, however, been obviated by a very ingenious contrivance. Some other substance is employed which strongly unites with the cloth and the colouring matter. This substance, therefore, is previously combined with the cloth, which is then dipped into a solution containing the colour. The colour then combines with the intermediate substances, which being firmly combined with the cloth, secures the permanence of the dye. Substances employed for this purpose are denominated *mordants*.

The method of colouring a scarlet dye, was discovered by Cornelius Drebbel, a citizen of Alenmaar, a man extremely well skilled in chemistry. Among other experiments, he left an account of one, concerning the method of dying wool with a bright flame colour; which his son-in-law Kufflaar, afterwards put in practice, and by which means he made a fortune.

Spirit of nitre has been found to improve the rich colour of cochineal, into the brightness of burning fire; but its acrimony corrodes and damages the wool, which is prevented by dulcifying it with tin, after which, it neither hurts wood or silk. Chemistry is likewise obvious in another point of view. "I once showed," says the learned Boerhaave, "colours which I had prepared from solutions of copper, to some skilful master dyers, who were surprised with the beauty of them, and would have given any money to have been able to give colours of such brightness to their stuffs, &c.; and no wonder, since the blue, violet and green of copper, which may be raised and weakened at pleasure, afford such a variety, that a person who can dye silk, woollen, cotton or linen cloths therewith will gain an immense estate." It has been said by a Spanish patriot, that "good dyers in silk and wool are few every where, and it should be considered," in regard to this art, "we depend upon it as one of the most essential recommendations of our manufactured goods, and what procures them the readiest sale, both at home and abroad; for it will turn to small account that the materials are good, and well wrought up, unless the mixture and colours be answerable and grateful to the eye of the purchaser.

The most important part of dying is the choice and application of *mordants*; as upon them the permanency of almost every dye depends. Mordants must be previously dissolved in some liquid, which has a weaker union with the mordant than the cloth has; and the cloth must then be steeped in this solution, so as to saturate itself with the mordant. The most important and most generally used mordant is *alumine*; it is used in the state of common alum, in which it is combined with sulphuric acid, or in that state called acetate of alumine. Alum to make a mordant is dissolved in water, and very frequently, a quantity of tartrate of potash is dissolved with it. Into this solution the woollen cloth is put and kept till it has absorbed as much alumine as necessary. It is then taken out, washed and dried.

*Acetate of Alumine*, is prepared as a mordant by pouring acetate of lead into a solution of alum, (see page 37, acetate of alumine.) This mordant is employed for *cotton* and *linen*. It answers much better for these than alum; the stuff is more easily saturated with alumine, and takes in consequence, a richer and more permanent colour. The white oxide of tin



has enabled the moderns greatly to surpass many of the ancients, in the fineness of their colours; and even to equal the famous Tyrian purple; and by means of its scarlet, the brightness of all colours is produced. It is the white oxide of tin alone that is the real mordant. Tin is used as a mordant in three states: dissolved in nitro-muriatic acid, in acetic acid, and in a mixture of sulphuric and muriatic acids; but nitro-muriate of tin is the common mordant used by dyers. It is prepared by dissolving tin in diluted nitric acid, to which a certain proportion of common salt, or sal ammoniac is added. When the nitro-muriate of tin is to be used as a mordant, it is dissolved in a large quantity of water, and the cloth is dipped in the solution, and allowed to remain until sufficiently saturated. It is then taken out, washed and dried. Tartar is usually dissolved in water, along with the nitro-muriate.

*Red Oxide of Iron*, is also used as a mordant in dying; it has a very strong affinity for all kinds of cloth, of which the permanency of red iron spots, or iron moulds on linen and cotton is a sufficient proof. As a mordant it is used in two states; in that of sulphate of iron, or copperas, and that of acetate of iron. The first, or copperas, is commonly used for *wool*. The copperas is dissolved in water, and the cloth dipped into it. It may be used, also for cotton, but in most cases acetate of iron is preferred, which is prepared by dissolving iron or its oxide in vinegar, sour beer, or pyroligneous acid, and the longer it is kept the better. *Tan* is very frequently employed as a mordant. An infusion of nutgalls, or of sumack, or any other substances containing tan, is made in water; and the cloth is dipped in this infusion, and allowed to remain till it has absorbed a sufficient quantity. Tan is also employed along with other mordants, to produce a compound mordant. Oil is also used for the same purpose, in dying cotton and linen. The mordants with which it is most frequently combined, are alumine and oxide of iron. Besides these mordants, there are several other substances frequently used as auxiliaries, either to facilitate the combination of the mordant with the cloth, or to alter the shade of colour; the chief of these are, tartar, acetate of lead, common salt, sal ammoniac, sulphur of copper, &c. Mordants not only render the dye perfect, but also have considerable influence on the colour produced. The same colouring matter produces

very different dyes, according as the mordant is changed. Suppose, for instance, that the colouring matter is cochineal; if we use the aluminous mordant, the cloth will acquire a crimson colour; but the oxide of iron produces, with it, a black. In dying then, it is not only necessary to produce a mordant, and a colouring matter of such a nature, that when combined together, they shall produce the wished for colour in perfection. But we must procure a mordant and a, colouring matter, of such a nature, that when combined together, they should possess the wished for colour; even a great variety of colours may be produced with a single dye stuff, provided we change the mordant sufficiently.

To determine the effects of various salts or mordants on colours: 1. *The dye of Madder.* For a madder red on woollens, the best quantity of madder is one half, for the woollens that are to be dyed; the best proportion of salts to be used in five parts of alum and one of red tartar, for sixteen parts of the stuff. A variation in the proportions of the salts wholly alters the colour that the madder naturally gives. If the alum is lessened, and the tartar increased, the dyes prove a *red cinnamon*. If the alum be entirely omitted, the red wholly disappears, and a durable tawny cinnamon is produced. If woollens are boiled in weak pearlash and water, the greater part of the colour is destroyed. A solution of soap discharges a part of the colour, and leaves the remaining more beautiful. Volatile alkalies heighten the red colour of the madder, but they make the dye fugitive.

2. *The Dye of Logwood.* Volatile alkaline salts or acids incline this to purple; the vegetable and nitrous acids, render it pale; the vitriolic and marine acids deepen it.

3. *Lime Water.* In dying browns or blacks, especially browns, lime water is found to be a very good corrective, as also, an alternative when the goods have not come to the shades required; but practice alone can shew its utility; it answers well for either woollens, silks, or cottons.

4. *To render Colours holding.* Brown or blues, or shades from them, require no preparation to make them receive the dye, and hold it fast when they have received it. Alum and tartar, boiled together, when cold, form a mastic, within the pores of the substance, that serves to retain the dye, and reflect the colour in a manner transparently. Almost all browns are deemed fast and holding colours, without any preparation,

the dying materials containing in themselves a sufficient degree of astringent quality to retain their own colours. Many reds, are also, equally holding, but none more so than those made with madder on woollens prepared with alum and tartar. A very fast red is also made with brazil wood, by boiling the woollen in alum and tartar, and suffering the cloth to remain several days in a bag, kept moist by the preparation liquor. The cause of the solidity of the colour from Brazil wood, dyed after this method, arises from the alum and tartar masticating itself within the pores of the wool in quite a solid state.

There is not a drug used in the whole art of dying, but may be made a permanent dye, by finding out a salt or solution of some metal, that, when once dissolved by acids, or by boiling water, will neither be affected by the air, nor be dissolved by moisture. Such are alum and tartar, the solution of tin, &c. But these salts and solutions do not answer with all ingredients that are used in dying.

*To Dye Wool and Woollen Cloths of a Blue Colour.*—One part of indigo in four parts concentrated sulphuric acid, dissolved; then add one part of dry carbonate of potash, and dilute with eight times its weight of water. The cloth must be boiled for an hour in a solution, containing five parts of alum, and three of tartar, for every thirty-two parts of cloth, then throw it into a water bath, previously prepared, containing a greater or smaller proportion of diluted sulphate of indigo, according to the shade which the cloth is intended to receive. Boil it in the bath until the colour desired is obtained. The only colouring matters employed in dying blue are indigo and woad. Indigo has a very strong affinity for wool, silk, cotton and linen. Every cloth, therefore may be dyed with it without the assistance of any mordant whatever. The colour thus induced is very permanent. But indigo can only be applied to cloth in a state of solution, and the only known solvent is sulphuric acid. The sulphate of indigo is often used to dye wool and silk blue, and is known by the name of Saxon blue.

It is not the only solution of that pigment employed in dying. By far the most common method is, to deprive the indigo of its blue colour, and reduce it to green, and then to dissolve it in water by means of alkalies. Two different methods are employed for this purpose. The first, is, to mix the indigo in a solution of green oxide of iron and different me-

tallic sulphurets. If, therefore, indigo lime, and green sulphate of iron are mixed together in water, the indigo gradually loses its blue colour, becomes green, and is dissolved. The second method is, to mix the indigo, in water, with certain vegetable substances, which readily undergo fermentation; the indigo is dissolved by means of quicklime or alkali, which is added to the solution. The first of these methods is usually followed in dyeing cotton and linen; the second in dyeing silk and woollen. In the dyeing of wool, woad and bran are commonly employed, as vegetable ferments, and lime as the solvent of the green base of the indigo; and by following the common process, indigo may be extracted from it. In the usual state of woad, when purchased by the dyer, the indigo which it contains, is probably not far from the state of green pollen. Its quantity in woad is but small, and it is mixed with a great proportion of other vegetable matter. When the cloth is first taken out of the vat, it is of a green colour, but it soon becomes blue. It ought to be carefully washed to carry off the uncombined particles. This solution of indigo is liable to two inconveniences: -1st, It is sometimes apt to run too fast, into the putrid fermentation; this may be known by the putrid vapours which it exhales, and by the disappearing of the green colour. In this state it would soon destroy the indigo altogether. The inconvenience is remedied by adding more lime, which has the property of moderating the putrescent tendency. 2dly, Sometimes the fermentation goes on too languidly. This defect is remedied by adding more bran or woad, in order to diminish the proportion of thick lime.

*To make Chemic Blue and Green.* Chemic, for light blues and greens on silk, cotton, or woollen, and for cleaning and whitening cotton, is made as follows. One pound of the best oil of vitriol, poured on one ounce of the best indigo, well pounded and sifted; add to this, after it has been well stirred, a small lump of common pearlash, as big as a pea, or from that to double the quantity. When the fermentation which is produced, ceases, put it into a bottle tightly corked, and it may be used the next day. Observe, if more than the quantity prescribed of pearlash should be used, it will deaden and sully the colour. Chemic for green as above for blue, is made by only adding one-fourth more of the oil of vitriol.

*To make a Solution of Tin in Aqua-Regia.* Eight ounces filtered river water, and eight ounces double aqua-fortis; mix; add gradually half an ounce of sal ammoniac, dissolved, piece by piece, and two drachms saltpetre. Then take one ounce of refined block tin; put it into an iron pan, and set it over the fire: when melted, hold it four or five feet over the vessel, and drop it into water, so as to let it fall to pieces. Then put a small piece of this granulated tin into the above aqua-regia, and when the last piece disappears, add more gradually till the whole is mixed; mind and keep it firmly corked. When finished it will produce a most excellent yellow, though should it fail in that respect, it will not be the worse for use; keep it cool, as heat will injure it, and even spoil it.

*To make Muriate of Tin.* Take eight ounces muriatic acid, and dissolve in it, by slow degrees, half an ounce granulated tin; when this is done, pour of the clear liquid into a bottle, and weaken it if required, with pure river water.

*To determine the effect of various Waters on different Colours.* Snow water contains a little muriate of lime, and some slight traces of nitrate of lime; rain water has the same salts in a larger quantity, and also carbonate of lime, muriate of lime, muriate of soda, or carbonate of soda. River water has the same substances, but in less abundance. Well water contains sulphate of lime, or nitrate of potash, besides the above mentioned salts. Should the water contain a salt or a mineral acid, in the first instance no acid will be required to neutralize it; or in the second, an alkali. Thus waters of any quality may be saturated by their opposites, and rendered neutral.

*To discharge colours.* The dyers generally put all coloured silks which are to be discharged, into a copper, in which half a pound or a pound of white soap is dissolved. They are then boiled off, and when the copper begins to be too full of colour, the silks are taken out and rinsed in warm water. In the interim a fresh solution of soap is to be added to the copper, and then proceed as before till all the colours are discharged. For those colours which are wanted to be effectually discharged, such as greys, cinnamon, &c. when soap does not do, tartar must be used. For slate colours, greenish drabs, olive drab, &c. oil of vitriol, in warm water must be used; if other colours, rock alum must be

boiled in the copper, then cooled down, and the silks entered and boiled off, recollecting to rinse them before they are again dyed. A small quantity of muriatic acid, diluted in warm water, must be used to discharge some fast colours; the goods must be afterwards well rinsed in warm and cold water to prevent any injury to the stalk.

*To discharge Cinnamons, Greens, &c.* when dyed too fully, take some tartar pounded in a mortar, sift it into a bucket, then pour over it some boiling water. The silks, &c. may then be run through the clearest of this liquor, which will discharge the colour, but if the dye does not take on again evenly, more tartar may be added, and the goods run through as before.

*To Re-Dye, or change the colour of Garments, &c.* depends upon the ingredients by which they have been dyed. Sometimes when these have been well cleansed, more dye stuff must be added, which will afford the colour intended, and sometimes the colour already on the cloth must be discharged and the articles re-dyed.

Every colour in nature will dye black, whether blue, yellow, brown, or red; and black will always dye black again. All colours will take the same colour again, which they already possess; and blues can be made green or black; green may be made brown and brown green; and every colour on re-dying will take a darker hue than at first. Yellows, browns, and blues are not easily disengaged; maroons, reds, of some kinds, olives, &c. may be discharged.

*Olive Greys, &c.* are discharged by putting in two or three table spoonfuls more or less, of oil of vitriol, then put in the garments, &c. and boil, and it will become white. If chemic green, either alum, pearlash, or soap, will discharge it off to the yellow; this yellow may be mostly boiled off with soap, if it has received a preparation for taking the chemic blue. Muriatic acid used at hard heat, will discharge most colours. A black may be dyed maroon, claret green, or a dark brown, but green is the principal colour into which black is changed.

*To alum Silks.* Silks should be alumed, when cold, for when they are alumed hot, they are deprived of a great part of their lustre. The alum liquor should always be strong for silks, as they take the dye more readily afterwards.

*To dye Silks Blue.* Silk is dyed light blue, by a ferment of six parts, six of indigo, six of potash, and one of madder. For a dark blue, it must previously receive what is called a

ground colour ; a red die stuff, called archil, is used for this purpose.

*To dye Cotton and Linen Blue.* Take a solution of one part indigo, one part green sulphate of iron, and two parts quicklime.

*Yellow Dyes.* Oxide of tin is sometimes used when very fine yellows are wanting. Tan is often employed as subsidiary to alumine, and in order to fix it more copiously on cotton and linen. Tartar is also used as an auxiliary, to brighten the colour ; and muriate of soda, sulphate of lime and even the sulphate of iron, to render the shade deeper. The yellow dye, by means of fustic is more permanent, but not so beautiful as that given by weld or quercitron. As it is permanent, and not much injured by acids, it is often used in dying compound colours, where a yellow is required. The mordant is alumine. When it is oxide of iron, fustic dies a good permanent drab colour. Weld and quercitron bark yield nearly the same colour ; but the bark yields colouring matter in greater abundance, and is cheaper than weld. The method of using each of these dye stuffs is nearly the same.

Yellow colouring matters have too weak an affinity for cloth, to produce permanent colours without the use of mordants. Cloth, therefore, before it is dyed yellow, is always prepared by soaking it in alumine.

*To Dye Woollens Yellow.* Let them be boiled for an hour or more, with one-sixth of its weight of alum, dissolved in a sufficient quantity of water as a mordant. Then plunge it without rinsing, into a bath of warm water, containing as much quercitron bark as equals the weight of the alum employed as a mordant. The cloth is to be turned through the boiling liquid, till it has acquired the intended colour. Then a quantity of clean powdered chalk, equal to the hundredth part of the weight of the cloth, is to be stirred in, and the operation of dying continued for eight or ten minutes longer. This method produces a pretty deep and lively yellow. For a very bright orange, or golden yellow, it is necessary to use the oxide of tin as a mordant. For producing bright golden yellows, some alum must be used along with the tin. To give the yellow a delicate green shade, tartar must be added in different proportions, according to the shade,

*To dye Silks Yellow.* They may be dyed different shades of yellow, either by weld or quercitron bark, but the last is

the cheapest. The proportion is from one to two parts of bark, to twelve parts of silk, according to the shade. Tie the bark up in a bag, and put it into the dying vessel while the water is cold. When it acquires the heat of about  $100^{\circ}$  the silk having been previously alumed, should be dipped in, and continued, till it assumes the wished for colour. When the shade is required to be deep, a little chalk, or pearlash should be added towards the end of the operation.

*To dye Linens and Cottons Yellow.* The mordant should be acetate of alumine, prepared by dissolving one part of acetate of lead, and three parts of alum, in a sufficient quantity of water. Heat the solution to the temperature of  $100^{\circ}$ , soak the cloth in it for two hours; then wring out and dry it. This may be again repeated, and if the shade of yellow is required to be very bright and durable, the alternate wetting with limestone and soaking in the mordant may be repeated three or four times.

The drying bath is prepared by putting twelve or eighteen parts of quercitron bark, (according to the depth of the shade required) tied up in a bag, into a sufficient quantity of cold water. Into this bath the cloth is to be put, and turned in it for an hour, while its temperature is gradually raised to about  $120^{\circ}$ . It is then to be brought to a boiling heat, and the cloth allowed to remain in it for only a few minutes. If kept long at a boiling heat, the yellow acquires a shade of brown.

*To fix a fine Mineral Colour on Wool, Silk, Cotton, &c.* Mix one lb. sulphur, two lbs. white oxide of arsenic, and five parts pearlash; and melt in a crucible at a little short of red heat. The result is a yellow mass, to be dissolved in hot water, and the liquor filtrated, to separate from a sediment formed chiefly of metallic arsenic, in shining plates, and in a small part of a chocolate coloured matter, which appears to be a sub-sulphuric acid, which produces a flacculent precipitate of a most brilliant yellow colour. This precipitate, washed upon a cloth filter, dissolves with the utmost ease in liquid ammonia, giving a yellow solution, which colour is to be removed by an excess of the same alkali.

*To prepare the Sulphurat of Arsenic.* This produces a very brilliant and permanent yellow. Dip into a solution of this more or less dilated, according to the depth of tint required, wool, silk, cotton or linen. All metallic utensils must be carefully avoided, When the stuffs come out of this



bath, they are colourless, but they insensibly take on a yellow hue as the ammonia evaporates. They are to be exposed as equally as possible to a current of open air; and when the colour is well come out, and no longer heightens, they are to be washed and dried. Wool should be fulled in the ammoniacal solution, and should remain in it, until it is thoroughly soaked; then very slightly and uniformly pressed, or else merely set to to drain of itself. Silk, cotton, hemp, and flax, are only to be dipped in the dyeing liquid, which they easily take. They must be then well pressed. The sulphuret arsenic will give every imaginable tint to stuffs, from the deep golden yellow, which has the invariable advantage of never fading, of lasting even longer than the stuffs themselves, and of resisting all re-agents, except alkalies. Hence it is peculiarly fitted for costly tapestry, velvets and other articles of furniture which are not in danger of being washed with alkalies or soap; and to which the durability of colour is a most important object. It may also be used with advantage in paper staining.

*To dye Woollens Red, Crimson and Scarlet.* Coarse woollen stuffs are dyed red with madder, or archili; but fine cloth is almost exclusively dyed with cochineal, though the colour it receives from kermes is more durable. Brazil wood is scarcely used, excepting as an auxiliary, because the colour which it imparts to the wool is not permanent. Wool is dyed crimson, by first impregnating it with alumine, by means of an alum bath, and then boiling in a decoction of cochineal, till it has acquired the wished for colour. The crimson will be finer if the tin mordant is substituted for alum; indeed, it is usual with dyers to add a little nitro-muriate of tin, when they want fine crimsons; the addition of archil and potash to the cochineal both render the crimson darker, and gives it the more bloom. But the bloom very soon vanishes. For the paler crimsons, only one half of the cochineal is withdrawn, and madder substituted in its place. Wool may be dyed scarlet, by first boiling it in a solution of murio-sulphate of tin, then dyeing it pale yellow with queacitron bark, and afterwards crimson with cochineal, for scarlet is a compound colour, consisting of crimson mixed with a little yellow.

*To carry the Colour into the body of the Cloth.* Make the moistened cloth pass through between rollers placed within and at the bottom of the dye vat, so that the web, passing

from one windlass through the dye vat, and being strongly compressed by the rollers in its passage to another windlass, all the remaining water is drawn out, and is replaced by the colouring liquid, so as to receive colour to its very centre. The winding should be continued backwards and forwards from one windlass to the other, and through the rolling press, till the dye is of sufficient intensity.

*To dye Silks Red, Crimson, &c.* Silk is usually dyed red with cochineal; or carthamus, and sometimes with Brazil wood. Kermes does not answer for silk. Madder is scarcely ever used for that purpose, because it does not yield a colour bright enough. Archil is employed to give silk a bloom; but it is scarcely ever used by itself, unless when the colour wanted is lilac. Silk may be dyed crimson by steeping it in a solution of alum, and then dying it in the usual way, in cochineal bath. The colours known by the name of poppy, cherry, rose, and flesh colour are given to silks by means of carthamus. The process consists merely in keeping the silk, as long as it extracts any colour in an alkaline solution of carthamus, into which as much lemon juice as gives it a fine cherry red colour, has been poured. Silk cannot be dyed a full scarlet; but a colour approaching to scarlet may be given to it, by first impregnating the stuff with murio-sulphate of tin, and afterwards dying it in a bath, composed of four parts of cochineal, and four parts of quercitron bark. To give the colour more body, both the mordant and the dye may be repeated. A colour approaching scarlet may be given to silk, by first dying it in crimson; then dying it with carthamins; and lastly, yellow without heat.

*To dye Linens and Cottons Red, &c.* Cotton and linen are dyed red with madder. The process was borrowed from the east; hence the colour is often called Adrianople, or Turkey red. The cloth is first impregnated with oil, then with galls, and lastly with alum. It is then boiled for an hour in a decoction of madder, which is commonly mixed with a quantity of blood. After the cloth is dyed, it is plunged into a soda lye, in order to heighten the colour. The red given by this process is very permanent, and when properly conducted, it is exceedingly beautiful. The whole difficulty consists in the application of the mordant, which is by far the most complicated in the whole art of dying. Cotton may be dyed scarlet, by means of murio-sulphate of tin, cochineal,

and quercitron bark, used as for silk, but the colour is too fading to be of any value.

**Black Dye.** The substances employed to give a black colour to cloth, are red oxyde of iron, and tan. These two substances have a strong affinity for each other, and when combined, assume a deep black colour, not liable to be destroyed by the action of air or light. Logwood is usually employed as an auxiliary, because it communicates lustre, and adds considerably to the fulness of the black. The decoction is at first a fine red, bordering on violet; but if left to itself, it gradually assumes a black colour. Acids give it a deep red colour, alkalies, a deep violet, inclining to brown; sulphate of iron renders it as black as ink, and occasions a precipitate of the same colour, cloth before it receives black colour, is usually died blue; this renders the colour much fuller and finer than it would otherwise be. If the cloth is coarse, the blue dye may be too expensive; in that case, a brown colour is given, by means of walnut peels.

**To dye Woollens Black.** Wool is dyed black by the following process. It is boiled for two hours in a decoction of nutgalls, and afterwards kept, for two hours more, in a bath, composed of logwood and sulphate of iron; kept during the whole time, at a scalding heat, but not boiling. During the operation, it must be frequently exposed to the air; because the green oxide of iron, of which the sulphate is composed, must be converted into red oxide, by absorbing oxygen, before the cloth can acquire a proper colour. The common proportions, are five parts galls, five sulphate of iron, and 30 of logwood for every 100 of cloth. A little acetate of copper is commonly added to the sulphate of iron, because it is thought to improve the colour.

**To Dye Silks Black.** Silk is dyed nearly in the same manner. It is capable of combining with a great deal of tan; the quantity is varied at the pleasure of the artist, by allowing the silk to remain a longer or a shorter time in the decoction.

**To Dye Cottons and Linens Black.** The cloth previously dyed blue, is steeped for twenty-four hours in a decoction of nutgalls. A bath is prepared, containing acetate of iron, formed by saturating acetic acid with brown oxide of iron; into this bath the cloth is put, in small quantities at a time, wrought with the hand for a quarter of an hour; then wrung out and dyed again; wrought in a fresh quantity of the

bath, and afterwards aired. These alternate processes are repeated till the colour wanted is given; a decoction of alder bark is usually mixed with the liquor containing the nut-galls.

*To Dye Wool, &c. Brown.* Brown or fawn colour, though in fact, a compound, is usually ranked among the simple colours, because it is applied to cloth by a single process. Various substances are used for brown dyes. Walnut peels, or the green covering of the walnut, when first separated, are white internally, but soon assume a brown, or even a black colour, on exposure to the air. They readily yield their colouring matter to water. They are usually kept in large casks, covered with water, for above a year before they are used. To die wool brown with them, nothing more is necessary, than to steep the cloth in a decoction of them, till it has acquired the wished for colour. The depth of the shade is proportioned to the strength of the decoction. The root of the walnut tree contains the same colouring matter, but in a smaller quantity. The bark of the birch also, and many other trees, may be used for the same purpose.

*To Dye Compound Colours.* Compound colours are produced by mixing together two simple ones; or which is the same thing by dying cloth first of the simple colour, and then by another. These colours vary to infinity, according to the proportions of the ingredients employed. From blue, red and yellow, *red olives*, and *greenish greys* are made.

From blue, red and brown, *olives* are made from the lightest to the darkest shades; and by giving a greater shade of red, the *slated* and *lavender greys* are made.

From blue, red and black, *greys* of all shades are made, such as *sage*, *pigeon*, *slate* and *lead greys*.

From yellow, blue and brown, are made *olives* of all kinds.

From brown, blue and black, are produced *brown olives*, and their shades.

From red, yellow and brown, are derived the *orange*, *gold colour*, *dead carnations*, *cinnamon*, *fawn* and *tobacco*, by using two or three of the colours required.

From yellow, red and black, *browns* of every shade are made.

From blue and yellow, *greens* of all shades.

From red and blue, *purples* of all kinds are formed.

*To Dye different shades of Green.* Wool, silk and linen

are usually dyed green, by giving them first a blue colour; and afterwards dying them yellow; when the yellow is first given several inconveniences follow: the yellow partly separates again in the blue vat, and communicates a green colour to it, then rendering it useless for every other purpose, except dying green. Any of the usual processes for dying blue and yellow may be followed, taking care to proportion the depth of the shades to that of the green required. When sulphate of indigo is employed, it is usual to mix all the ingredients together, and to dye the cloth at once; this produces what is known by the name of Saxon, or English green.

*To Dye Violet, Purple and Lilac.* Wool is generally first died blue, and afterwards scarlet, in the usual manner. By means of cochineal mixed with sulphate of indigo, the process may be performed at once.

Silk is first died crimson by means of cochineal, and then dipped into the indigo vat. Cotton and linen are first died blue, and then dipped in a decoction of logwood, but a more permanent colour is given by means of oxide of iron.

*To Dye Olive, Orange, and Cinnamon.* When blue is combined with red and yellow on cloth, the resulting colour is olive. Wool may be dyed orange, by first dying it scarlet, and then yellow. When it is dyed first with madder, the result is a cinnamon colour. Silk is dyed orange by means of carthamus; a cinnamon colour by logwood, Brazil wood, and fustic, mixed together. Cotton and linen receive a cinnamon colour by means of weld and madder; and an olive colour by being passed through a blue, yellow, and then a madder bath.

*To Dye Grey, Drab, and dark Brown.* If cloth is previously combined with brown oxide of iron, and afterwards dyed yellow with quercitron bark, the result will be a drab of different shades, according to the portion of mordant employed. When the proportion is small, the colour inclines to olive, or yellow; on the contrary, the drab may be deepened, or *saddened* as the dyers term it, by mixing a little sumach with the bark.

*To Dye Olives, Bottle Greens, Purples, Browns, Cinnamons, or Snuffs.* Take common iron liquor, or alum dissolved in it, a quantity of each according to the shade wanted, made into a paste or liquid by adding flour, gum, glue, linseed, or one or more of them. Then put the composition

into a tub connected with a machine used for such purposes; take them from the machine, and hang them up in a very cool room: where they should remain until dry. Take cow's manure, put it into a large copper of hot water, and mix well together; through which pass the cloth, until thoroughly softened. After this process, cleanse the goods; then take a liquor made of madder, logwood, sumach, fustic, Brazil wood, quercitron bark, peach, or other woods, to produce the colour wanted, or more of them; and if necessary dilute this liquor with water, according to the shade or fulness of the colour wanted to be died. Then work the goods through this liquor; after which pass them through cold or warm water, according to colour, the proper application of which is well known to dyers, adding a little alum, copperas, or Roman vitriol, or two or more of them first dissolved in water. Then wash them off in warm water, and dry them. But if the colour is not sufficiently full, repeat the same operation till it is brought to the colour required.

*To Dye a Black upon Cotton, Linen, and mixed Goods*, is effected by tar and iron liquor of the best quality, adding to each gallon of the mixture, a pound of fine flour. Some take common iron liquor, and add three quarters of fine flour, and by boiling, bring it to the consistence of a thin paste, or instead of flour, add glue or linseed, or gum, or all of them mixed together, and brought to a proper thickness. The rest of the process is conducted in a similar manner to the last.

*To Dye Crimson, Red, Orange, or Yellow*.—Take red liquor, such as is generally made from alum, and dilute it with water according to the strength or shade of colour wanted to dye, bringing it to the consistency of a paste or liquid, as before described; then pass the cloth through the machine, which, being dried in a cool room, pass it through the operation as described in the article on olives, bottle greens, &c. then take a quantity of liquor made of cochineal, madder, peach wood, Brazil, logwood, woad, fustic, sumach, or any two or more of them, proportioned in strength, to the shade or colour wanted to dye, and work the goods through this liquor, till they are brought to the shade of colour required; then wash them in cold or warm water and dry them.

*To Dye Cotton, Wool, and Silk with Prussian Blue*. Immerse the cotton in a large tub of water slightly acidulated and charged with Prussiate of potash. These sorts of stuffs

died in Prussian blue, and then in olive transformed into green, are particularly sought after in trade. By processes analogous to those employed for common stuffs, the inventor has obtained the same shades and colours, on samples of silk, and for many years he has succeeded in fixing Prussian blue on wool; and in producing on cloth the same shades, as on cotton and silk.

*To precipitate Acetates of Lead and Copper on Wool, Silk, and Cotton.* Soak the stuff to be dyed, in a solution of acetate, or rather sub-acetate, of lead, wring it when taken out of the bath, dry in the shade; then wash it and immerse it in water charged with sulphuretted hydrogen gas. This process produces in a few minutes, rich and well laid shades, which vary from the clear *vigone* colour, to the deep brown, according to the force of the mordant, and the number of the immersions of the stuffs in the two bathing vessels. From the order of affinities, it is the wool which takes colour the best, afterwards the silk, then the cotton, and lastly the thread which appears little apt to combine with the mordant. The different colours above indicated resist the air well, likewise feeble acids, alkalies, and boiling soap, which modify their shades in an imperceptible manner, and these shades are so striking, that it will appear difficult to obtain them in any other way.

This new kind of dye is very economical; the sulphuretted hydrogen gas is obtained from a mixture of two parts of iron filings and one of brimstone, melted in a pot; the brimstone is bruised, introduced into a matrass, and the gas is removed by sulphuric acid, extended in water to a mild heat. The gas absorbs abundantly in cold water.

*To Dye Cotton Cloth Black.* Take a quantity of Molacca nuts, and boil them in water, in close earthen vessels, with the leaves of the tree. During the boiling, a whitish substance, formed from the mucilage and oil of the nuts, will rise to the surface; this must be taken off and preserved. The cloth intended to be black must be printed with this scum, and then died, after which, let it be passed through lime-water, when the painted figures will be changed to a full and permanent black.

*To Dye Wool a permanent Blue Colour.* Take four ounces of the best indigo, reduce it to a fine powder and add twelve pounds of wool, in the grease; put the whole into a copper large enough to contain all the wool to be died. As

soon as the requisite colour is obtained, let the wool be well washed and dried. The liquor remaining, may be again used, to produce lighter blues. The colour will be very beautiful, and permanent as the finest blue produced by woad; and the wool, by this method will lose less in weight, than if it had been previously secured.

*To produce the Swiss deep and pale Red topical Mordant.* When the cloth has been freed by steeping and boiling in soap and water, from the paste used by the weaver, and any other impurities it may have acquired, immerse it thoroughly, or as it is called, tramp or pad it in a solution of any alkali, and oil or grease, forming an imperfect soap dissolved in water, or in a solution of soda and gallipoli oil, in the proportion of one gallon of oil to twenty gallons of soda lees, at the strength of four degrees and a half; then dry the cloth in the stove; and repeat the process several times, which may be varied at pleasure, according to the lustre and durability of the colour wanted, stove drying the cloth between every immersion. To the above solutions a little sheep's manure for the first three immersions; after the cloth has been immersed in these liquors, steep it in a quantity of water, for twelve hours, at 110 deg. Fahrenheit; the cloth being again stove dried is immersed in a solution of alkali and oil, or grease, or boiled in perfect soap dissolved; which process must be repeated, according to the brilliancy of the colours wanted; stove drying as before between every immersion; these are called the *white liquors*. Steep the cloth for twelve hours, at 125 deg. Fahrenheit, which forms what is called the white steep. The cloth being now thoroughly washed in cold water, and dried, is ready to receive, first, the pink mordant, composed as follows: equal quantities by measurement of a decoction of galls, at the strength of four to six, and a solution of alum at one half degree, the alum being previously saturated with whitening, or any other alkali, in the proportion of one ounce to the pound weight of alum; mix them together, and raise the temperature to 140 deg. of Fahrenheit, or as hot as can be handled. By immersion, as formerly mentioned in this mixture, the cloth when died and cleared, exhibits a beautiful pink, equal, if not superior to that produced by cochineal.

*To dye Silks and Satins Brown, in the small way.* Fill the copper with river water; when it gently boils, put in a



quarter of a pound of chipped fustic, two ounces of madder, one ounce of sumach, and half an ounce of camwood, but if it is not required to be so red, the camwood may be omitted. These should boil at least, from half an hour to two hours, that the ingredients may be well incorporated. The copper must then be cooled down by pouring in cold water; the goods may then be put in and simmered gently from half to an hour.

If this colour should appear to want darkening, it may be done by taking out the goods; and adding a small quantity of old black liquor; a small piece of green copperas may be used; rinse in two or three waters, and hang up to dry.

*To dye Silk Fawn Colour Drabs.* Boil one ounce fustic, half an ounce of alder bark, and two drachms of archil. From one to four drachms of the best madder must be added to a very small quantity of old black liquor, if it required darker.

*To die a Silk Shawl Scarlet.* Dissolve two ounces of white soap in boiling water, handle the shawl through the liquor, rubbing such places with the hands as may appear dirty. A second or third liquor may be used, if required; after which rinse out the shawl in warm water. Then take half an ounce of the best Spanish arnotto, dissolve it in hot water; pour the solution into a pan of warm water, handle the shawl in it a quarter of an hour, then rinse it in clean water. In the meanwhile dissolve a piece of alum, of the size of a horse bean in warm water, let the shawl remain in this half an hour, then rinse it in clean water. Now boil a quarter of an ounce of the best cochineal for twenty minutes, dip it out of the copper into a pan, let the shawl remain in this from twenty minutes to half an hour, when it will become a blood red; then take it out and add to the liquor in the pan, a quart more out of the copper, if there is as much remaining, and about half a small wine glass full of the solution of tin; when cold, rinse it out slightly in cold water.

*To dye a Silk Shawl Crimson.* Take about a table-spoonful of cudbear, put it into a small pan, pour boiling water upon it, stir and let it stand a few minutes, then put in the silk, and turn it over a short time, and when the colour is full enough, take it out; but if it should require more violet or crimson, add a spoonful or two of purple archil to some warm water, and dry it within doors. To finish, it must be calendered, and then pressed.

*To dye thick Silks, Satins, Silk Stockings, &c. Flesh Colour.* Wash the stockings clean in soap and water, and rinse in hot water; if they should not appear perfectly clear, cut half an ounce of white soap into slices, put it into a sauce pan half full of boiling water; when it is dissolved, cool the water in the pan, then put in stockings, and simmer twenty minutes, when they should be rinsed in hot water; in the interim pour three table spoonfuls of purple archil into a wash basin half full of hot water; dye the stockings in this liquor, and when nearly of the shade of half violet or lilac, slightly rinse them in cold water; when dry, hang them up in a close room, in which sulphur is burnt; when they are evenly bleached to the shade required, finish by rubbing the right side with a flannel. Some prefer calendering them afterwards. Satins and silks are done in the same way.

*To dye Silk Stockings Black.* These are dyed like other silks, excepting they must be steeped a day or two in black liquor, before they are put into the black silk dye. At first they will look like an iron grey, but to finish and black them, they must be put on wooden legs, laid on a table and rubbed with the oily rubber or flannel, upon which is oil of olives. For each pair it will require half a table spoonful of oil, and half an hour's rubbing, to finish them well.

*To dye Straw and Chip Bonnets Black.* Chip hats are stained black in various ways. 1st. By being boiled in strong logwood liquor three or four hours; they must be often taken out to cool in the air, and occasionally a small quantity of copperas must be added. The bonnets may be kept in the vessel containing the liquor one night, and in the morning dried in the air, and brushed with a soft brush. Lastly, a sponge is dipped in oil, and squeezed almost to dryness; with this rub them all over. Some boil them on logwood, and instead of copperas, use steel filings steeped in vinegar; when they are finished as above.

*To dye Black Cloth Green.* Clean the cloth well with bullock's gall and water; rinse in warm water; make a copper full of river water boiling hot, and take from one to one pound and a half of fustic; add to the water, and boil twenty minutes; put in a lump of alum of the size of a walnut; when dissolved, put in the article to be dyed, and boil twenty minutes; then take it out, and add a small wine glass three parts full of chemic blue, and boil again from half to an hour, when

the cloth will become a beautiful green ; than wash out and dry.

*Saxon Blue, Scott's Liquid Blue.* Indigo, one pound, oil of vitriol four pounds—dissolve by keeping the bottle in boiling water ; then add twelve pounds of water, or q. p.

*An excellent dye, the basis of many colours.* A decoction of the seeds of red Trefoil is mixed with different mineral substances ; the dyes produced are very beautiful, and of a great variety. Among them are yellow and green of different shades, as also citron and orange colours. These dyes are well adapted to woollen and cotton manufactures : they resist the action of the substances, with which trials are usually made, much better than the common dyes.

*Pink Dye.* Tie safflower in a bag and wash it in water, until it no longer colours the water ; then dry it :—of this take two drachms, salt of tartar, eighteen grains, spirits of wine, seven drachms ; digest for two hours, add two ounces of distilled water, digest for two hours more, and add a sufficient quantity of distilled vinegar or lemon juice, to render it a fine rose colour, used as a cosmetic and to make French rouge.

*Nankeen Dye.* Arnatto, prepared kali, of each equal parts, boiled in water ;—the proportion of the kali is altered as the colour is required to be deeper or lighter ; used to restore the colour of faded nankeen.

*Scarlet Colour—Muriate of Tin.* Prepare the nitromuriatic acid by mixing one part of muriatic acid with two of nitric acid, and put a very small quantity into a Florence flask. Drop tin into it by small quantities, that it may not become too hot by the rapid union of the tin and acid. After the acid is saturated, dissolve some of it in water. Dissolve in water in a wine-glass, a single cochineal insect of the shops, and drop in a little muriate of tin, and it will become a bright scarlet.

## CHAPTER XXVI.

*The art of Calico printing, to prepare dying materials—  
Litmus—Saffron—Woad—Indigo—Potatoe tops, &c.*

This art consists in dying cloth with certain colours and figures upon a ground of a different hue : the colours, when they will not take hold of the cloth readily, being fixed to

them by means of mordants, as a preparation of alum made by dissolving three pounds alum and one pound of acetate of lead, in eight pounds of warm water. There are added at the same time, two ounces of potash, and two ounces of chalk. Acetate of iron, is also a mordant in frequent use; but the simple mixture of alum and acetate of lead, is found to answer best as a mordant. The mordants are applied to the cloth, either with a pencil, or by means of blocks, on which the pattern, according to which the cotton is to be printed is applied, is cut. As they are applied to only particular parts of the cloth, care must be taken that none of them spread to the part of the cloth which is to be left white, and that they do not interfere with another, when several are applied; it is necessary, therefore, that the mordants should be of such a degree of consistence, that they will not spread beyond those parts of the cloth, on which they are applied. This is done by thickening them with flour or starch, when they are to be put on with the pencil. The thickening should never be greater than is sufficient to prevent the spreading of the mordants; when carried too far, the cotton is apt not to be sufficiently saturated with the mordants, and of course the dye takes but imperfectly. In order that the parts of the cloth impregnated with mordants may be distinguished by their colour, it is usual to tinge them with some colouring matter. A decoction of Brazil wood is generally used for this purpose. After the mordants have been applied, the cloth must be completely dried. It is proper for this purpose to employ heat, which will contribute towards the separation of the acetous acid from its base, and towards its evaporation; by which means the mordant will combine in a greater proportion, and more intimately with the cloth. When the cloth is sufficiently dried, it is to be washed with warm water and cowdung, till the flour or gum employed to thicken the mordants which are uncombined with the cloth, are removed. After this the cloth is to be thoroughly rinsed in clear water. Indigo not requiring any mordant is commonly applied at once, either by a block or pencil. It is prepared by boiling it with potash, made caustic by quicklime and orpiment; the solution is afterwards thickened with gum. It must be carefully secluded from the air, otherwise the indigo would soon become regenerated, thus rendering the solution useless. Some have used coarse brown sugar instead of orpiment. It

is equally efficacious in decomposing the indigo, and rendering it soluble, while it likewise serves all the purposes of gum.

*To paint Yellow.* For yellow, the block is besmeared with acetate of alumine. The cloth after receiving this mordant, is dyed with quercitron bark, and is then bleached.

*Nankeen Yellow,* is one of the most common colours on prints, is a kind of nankeen yellow, of various shades down to a deep yellowish brown or drab. It is usually in stripes or spots. To produce it, besmear a block, cut into the figure of a print, with acetate of iron, thickened with gum or flour; and apply to the cotton, which after being dried and cleansed in the usual manner; is plunged into a potash lye. The quantity of acetate of iron is always proportioned to the depth of the shade.

*Red,* is communicated by the same process, only madder is substituted for the bark.

*Blue.* The fine light blues which appear so frequently on printed cottons, are produced by applying to the cloth a block besmeared with a composition, consisting partly of wax, which covers all those parts of the cloth which remain white. The cloth is then dyed in a cold indigo vat; and after it is dry, the wax composition is removed by hot water.

*Lilac and Brown.* Lilac, fleece brown, and blackish brown, are given by means of acetate of iron; the quantity of which is always proportioned to the depth of shade. For very deep colours a little sumach is added. The cotton is afterwards dyed in the usual manner with madder, and then bleached.

*Green.* To twelve quarts of muriatic acid, add by degrees one quart of nitrous acid; saturate the whole with grain tin, and boil it in a proper vessel, till two thirds are evaporated. To prepare the indigo for mixing with the solution, take nine pounds of indigo, half a pound of orange orpiment, and grind it in about four quarts of water; mix it well with the indigo, and grind the whole in the usual way.

*To mix the solution of Tin with prepared Indigo.* Take two gallons of the indigo prepared as above, then stir into it by degrees, one gallon of the solution of tin, neutralized by as much caustic alkali as can be added without precipitating the tin from the acids. For a lighter shade of green, less indigo will be necessary. The goods are to be dipped in the way of dipping China blues; they must not however be al-

lowed to drain, but moved from one vat to another as quickly as possible. They are to be cleansed in the usual way: in a sour vat of about one hundred and fifty gallons of water to one gallon of sulphuric acid; they are then to be well washed in decoctions of weld, and other yellow colouring drugs, then branned or bleached till they become white in those parts which are required colourless.

*To print Dove Colour and Drab.* Dove colour and drab are given by acetate of iron, and quercitron bark, the cloth is afterwards prepared in the usual manner.

*To print different Colours.* When different colours are to appear in the same print, a greater number of operations are necessary. Two or more blocks are employed: upon each of which, that part of the print only is cut, which is to be of some particular colour. These are besmeared with different mordants, and applied to the cloth, which is afterwards dyed as usual. Let us suppose for instance, that those blocks are applied to cotton, one with acetate of alumine, another with acetate of iron, a third with a mixture of those two mordants, and that the cotton is then dyed with quercitron bark, and bleached. The parts impregnated with the mordants, would have the following colours:

Acetate of alumine,	Yellow.
“ iron,	Olive, drab, dove.
The mixture,	Olive green, olive.

If the part of the yellow is covered over with the indigo liquor, applied with a pencil, it will be converted into green: By the same liquid, blue may be given to such parts of the print as require it. If the cotton is dyed with madder, instead of quercitron bark; the print will exhibit the following colours:

Acetate of alumine,	Red.
“ iron,	Brown, black.
The mixture,	Purple.

When a greater number of colours are to appear; for instance, when those communicated by bark, and those by madder are wanted at the same time, mordants for parts of the pattern are to be applied, the cotton then is to be dyed in the madder bath, and bleached; then the rest of the mordants, to fill up the patterns, are added, and the cloth is again dyed with quercitron bark, and bleached.

The second dying does not so much affect the madder col-

ours; because the mordants, which render them permanent, are already saturated. The yellow tinge is already removed, by the subsequent bleaching. Sometimes a new mordant is applied to some of the madder colours, in consequence of which, they receive a new permanent colour from the bark. After the last bleaching, new colours may be added, by means of the indigo liquor. The following table will give an idea of the colours which may be given to cotton by these processes.

I. <i>Madder Dye.</i>	Acetate of alumine,	Red.
	“ iron,	Brown, black.
	“ diluted,	Lilac.
II. <i>Black Dye</i>	Both mixed,	Purple.
	Acetate of alumine,	Yellow.
	“ iron,	Dove, drab.
	Lilac and acetate of alum.	Olive.
	Red and acetate of alum.	Orange.
III. <i>Indigo Dye.</i>	Indigo,	Blue.
	Indigo and yellow,	Green.

*To prepare a Substitute for Gum, used in Calico Printing.* Collect half a ton weight of pelts or skins, or pieces of rabbit or sheep skins, and boil them for seven or eight hours, in 350 gallons of water; or until it becomes a strong size. Then draw it off, and when cold weigh it. Warm it again, and to every hundred weight, add the strongest sweetwort, that can be made from malt, or twenty pounds weight of sugar. When incorporated, take it off; and put it into a cask, for use. This substitute for gum may be used by calico printers in mixing up nearly all kinds of colours. By using only a sixth part of gum with it, it will also improve the gum, and be a saving of 200 per cent. and without gum, of 400 per cent. It will also improve and preserve the paste so much used by printers.

*To prepare Arnotto for Dying.* Arnotto is a colouring fecula of a resinous nature, extracted from the seeds of a tree very common in the West Indies, and which in height never exceeds fifteen feet. The Indians employ two processes to obtain the red fecula of these seeds. They first pound them, and mix them with a certain quantity of water, which in the course of five or six days, favours the progress of fermentation. The liquid then becomes charged with the colouring part, and the superfluous moisture is afterwards

separated by slow evaporation over the fire, or by the heat of the sun. The second process consists in rubbing the seeds between the hands in a vessel filled with water. The colouring part is precipitated, and forms itself into a mass like a cake of wax; but if the red fecula, thus detached, is much more beautiful than in the first process, it is less in quantity. Besides as the splendour of it is too bright, the Indians are accustomed to weaken it by a mixture of red sandal wood.

The natives of the East India islands used formerly to employ arnotto for painting their bodies, &c. At present in Europe it is only employed to give the first tints to woollen stuffs, intended to be dyed red, blue, yellow, green, &c. In the art of the varnisher, it forms part of the composition of changing varnishes, to give a gold colour to the metals on which these varnishes are applied,

*To prepare Dying Materials, &c.* Arnotto ought to be chosen of a flame colour, brighter in the interior part than on the outside; soft to the touch, and of a good consistence. The paste of arnotto becomes soft in Europe; and it loses some of its odour, which approaches near to that of violets.

*Of Litmus.* The Cape de Verd islands produce a kind of lichen or moss, which yields a violet colouring part, when exposed to the contact of ammonia disengaged from urine, in a state of putrefaction, by a mixture of lime. When the processes are finished, it is known by the name of litmus. This article is prepared on a large scale at London, Paris, and Lyons. In the latter city, another kind of lichen, which grows on the rocks is prepared.

The ammonia joins the resinous part of the plant, develops its colouring part, and combines with it. In this state the lichen forms a paste of a violet red colour, interspersed with whitish spots, which give it a marbled appearance. Litmus is employed in dying, to communicate a violet colour to silk and woollen.

*Of Saffron.* The flowers of this plant contain two colouring parts, one soluble in water, which is thrown away; the other soluble in alkaline liquors. The latter colouring parts becomes the basis of various beautiful shades of cherry colour, rose colour, &c. It is employed for dying feathers, and constitutes the vegetable red, or Spanish vermillion, employed by ladies to heighten their complexion. Carthamus cannot furnish its resinous colouring part, provided with all its qualities, until it has been deprived of that which is soluble in water. For this purpose, the dried flowers of the carthamus are enclosed in a lined bag, and the bag is placed in a



stream of running water. A man with wooden shoes gets upon the bag every eight or ten hours, and treads it on the bank until the water expressed from it is colourless. These moist flowers, after being strongly squeezed in the bag, are spread out on a piece of canvass, extended on a frame, placed over a wooden box, and covered with five or six per cent. of their weight of carbonate of soda. Pure water is then poured over them; and this process is repeated several times, that the alkali may have leisure to become charged with the colouring part, which it dissolves. The liquor when filtered is a dirty red, and almost brown colour. The colouring part thus held in solution, cannot be employed for colouring bodies until it is free; and to set it at liberty, the soda must be brought into contact with a body which has more affinity for it.

It is on this precipitation, by an intermediate substance, that the process for making Spanish vermilion is founded, as well as all the results arising from the direct application of this colouring part in the art of dying.

*Of Woad.* The preparation for colouring is effected from the leaves of the plant, by grinding them to a paste, of which balls are made, placed in heaps, and occasionally sprinkled with water to promote the fermentation; when this is finished, the woad is allowed to fall into a coarse powder; used as a blue dye stuff.

*Of Indigo.* This dye is derived from the leaves of the young shoots of several species of the plant, by soaking them either in cold water, or still better, in water kept warm, and at about 160° Fahrenheit, till the liquor becomes a deep green; it is then drawn off, and the blue sediment dried, and formed into lumps.

*Of Potatoe Tops, &c.* Cut off the tops when they are in flower, and extract the juice, by bruising and pressing them. Linen or woollen imbued in this liquor forty-eight hours, will take a brilliant, solid and permanent yellow. If the cloth be afterwards plunged in a blue dye, it will acquire a beautiful permanent green colour. As to the mode of execution, it should pass through the hands of a chemist or skilful dyer, to derive all the advantages it is capable of furnishing. To prepare cotton and linen to receive certain colours, particularly the red madder, and cross wort, the article of sheep's manure is made use of, as it forms, by impregnating the stuffs.

with an animal mucilage, of which it contains a large quantity, and thus assimilating them to wool and silk.

*To Print Carpets.* These carpets are made of knitted wool, by means of a machine; they are afterwards pressed and receive all the colours and designs wished for. These designs printed on the tissue, by means of wooden boards, are extremely neat; the colours are very brilliant, and resist rubbing extremely well, provided they traverse the tissue from one part to another. They are warm, and have the advantage of being cheaper than others. They are also as durable, and are not crossed by seams disagreeable to the eye.

## CHAPTER XXVII.

*Bleaching—by Oxymuriatic Acid—bleach field in Ireland—improved bleaching Liquor—by Alkalized Steam—to bleach Wool, Cotton and Straw—to whiten Wax—of purifying Tallow—imitation of Wax Candles—to extinguish Vegetable colours—bleaching Salts—bleaching Liquid.*

The mode of bleaching which least injures the texture of the cloth formed of vegetable substances, is that effected by merely exposing it in a moistened state to the atmosphere, having been steeped in a solution of potash or soda, but the length of time and other inconveniences attending this process, led to more active chemical processes. It is by the combination of oxygen with the colouring matter of the cloth, that it is deprived of its hue, and the different processes employed must be adapted to prepare it for this combination, and render it as perfect as possible, without destroying its texture, an effect which, however, must necessarily ensue in a greater or less degree, from the union of oxygen with all bodies.

To bleach linen, &c. by oxymuriatic acid, it is necessary to ascertain its strength, in which a solution of indigo in the acid is employed. The colour of this is destroyed by the oxygenated muriatic acid; according to the quantity of it that can be discoloured by a given quantity of the liquor its strength is known. In this country, machinery is employed for rinsing and beating; the apparatus must be arranged according to the objects to be bleached; the skeins of thread must be suspended in the tub destined for them, and the cloth must

be rolled upon reels in the apparatus. When every thing is thus disposed, the tubs are filled with oxygenated muriatic acid; by introducing a funnel, which descends to the bottom of the tub, in order to prevent the dispersion of gas. The cloth is wound on the frame work, on which the skeins are suspended, is turned several times, until it is judged, by taking out a small quantity of the liquor from time to time, and trying it by the test of the solution of indigo, that it is sufficiently exhausted.

The weakened liquor is then drawn off, and may be again used for a new saturation. In bleaching with the oxymuriate of lime, a large quantity of lime is combined with the oxymuriatic acid gas, to effect which, the lime is mechanically suspended in water, into which the gas is made to pass, and agitated; so as to present fresh matter to the gas. By this means the oxymuriate of lime is formed in a very convenient manner; it is dissolved in water, and used as a bleaching liquor. This liquor is preferable to the oxygenated muriatic acid and potash.

At the great bleach field in Ireland, four lyes of potash are applied alternately, with four weeks exposure on the grass, two immersions in the oxymuriate of lime, a lye of potash between the two, and the exposure of a week on the grass, between each lye and the immersion. During summer two lyes and fifteen days exposure are sufficient to prepare cloth for the oxygenated muriate; the three alternate lyes, with immersions in the liquor, will be sufficient to complete the bleaching; nothing then will be necessary, but to wind the cloth through the sulphuric acid.

The oxygenated muriatic gas may also be combined with lime in a dry state, or the water may be evaporated, when it is employed for the formation of oxymuriates, which may then be very conveniently transported to any distance without injury to its deterative power.

To prepare the sulphate of lime, take sulphur or brimstone in fine powder, four pounds; lime well slacked and sifted, twenty pounds; water sixteen gallons; these are to be well mixed, and boiled for half an hour in an iron vessel, stirring them briskly from time to time. Soon after the agitation of the boiling is over, the solution of the sulphuret of lime clears, and may be drawn off free from the insoluble matter, which is considerable, and which rests upon the bottom of the boiler. The liquor in this state, is nearly the colour of small

beer, but not so transparent. Sixteen gallons of fresh water are afterwards poured on the insoluble dregs in the boiler, in order to separate the whole of the sulphuret from them. When this clears, being previously agitated, it is drawn off and mixed with the first liquor. Thirty-three gallons more of water may be added to the liquor, thus reducing it to a proper standard for steeping the cloth; and which furnishes sixty gallons of liquor from four pounds of brimstone, making allowance for evaporation. When linen is freed from the weaver's dressing, it is to be steeped in the solution of sulphuret of lime (prepared as above) for about twelve or more hours, and then washed and dried. This process is to be repeated six times, that is, by six alternate immersions in each liquor, which has been found to whiten the linen.

Steam has lately been employed with great success. The process was brought from the Levant. Chapel first make it known to the public. The cloth is first immersed in a slight alkaline caustic liquor, and placed in a chamber constructed over a boiler, into which is put the alkaline lye, which is to be raised into steam, after the fire has been lighted, and the cloth has remained exposed to the action of the steam for a sufficient length of time, it is taken out and immersed in the oxygenated muriate of lime, and then exposed for two or three days on the grass. This operation, which is very expeditious, will be sufficient for cotton; but if linen cloth should retain a yellow tint, a second alkaline caustic vapour bath, and two or three days on the grass, will be sufficient to give it the necessary whiteness.

To bleach by alkalized steam, the high temperature swells up the fibres of the cloth; the pure alkali which rises with the elastic fluid, seizes with avidity on the colouring matter; and seldom does the tissue of the flax or hemp resist the penetrating effect of this vapour bath.

The alkali appears to have a much livelier and more caustic action, when it is combined with caloric, than in ordinary lyes, where the temperature never rises above  $162^{\circ}$  Fahrenheit. By making the cloth pass through the lye of oxygenated muriate of lime, an union is effected between the solution and the carbon, arising from the extractomucous matter of the flux; carbonic acid is formed; the water, even, in which this new compound is diluted, concurs to promote the combination; if the cloth is then exposed on the grass, the carbonic acid is dissipated, and the cloth is bleached.

**To Bleach Cotton.** The first operation consist in scouring it in a slight alkaline solution ; or what is better, by exposure to steam. It is then put into a basket, and rinsed in running water. The immersion of cotton in an alkaline lye, however it may be rinsed, always leaves with it an earthy deposite. It is well known that cotton bears the action of acids better then hemp or flax; that time is even necessary before the action of then can be prejudicial to it, and by taking advantage of this valuable property in regard to bleaching, means have been found to free it from the earthy deposite, by pressing down the cotton in a very weak solution of sulphuric acid, and afterwards removing the acid by washing, lest too long remaining in it should destory the cotton.

**To extinguish Vegetable Colours.** Obtain chlorine as follows: fill a strong quart decanter one third full of water, put in a pulverized mixture, consisting of half a gill of red lead, and a gill of common table salt, well rubbed together ; shake it up, then put in two thirds of a wine glass of sulphuric acid ; put in the ground stopper loosely ; shake the decanter half a minute ; the atmospheric air and some gas will escape ; now fix your stopper perfectly tight, then plunge the decanter into a tub or cistern of cold water, keeping the mouth a little above the water ; briskly agitate it, keeping it under the water, once each minute for fifteen minutes. Now take it out and let the excess of red lead and salt settle ; a yellowish green liquid is produced, nearly pure, but containing some muriatic acid ; pour a little into a wine glass, and it is ready for use to wash out writing from paper, or extinguish the colour from calico.

The liquid chlorine obtained in this way, should be kept in a dark and cool place. It is used for taking spots out of linen, &c. It has been used for fraudulent purpose, to obliterate writing, that something different might be substituted.

**Bleaching Liquid—Eau de Javelle.** Common salt, two pounds ; manganese, one pound ; water, two pounds ; put into a retort ; and add gradually, oil of vitriol, two pounds : pass the vapour through a solution of prepared kali, four ounces, in twenty-nine ounces of water, applying heat towards the last. Specific gravity is 1,087. Stimulant, antisypilitic ; used to bleach linen and take out spots, and to clean books from what has been scribbled on their margins.

*To Bleach Wool.* The first kind of bleaching to which wool is subjected, is to free it from grease. This operation is called scouring. In manufactories it is generally performed by ammoniacal lye, formed of five measures of river water, and one of stale urine; the wool is immersed for about twenty minutes, in a bath of this mixture, heated to fifty-six degrees; it is then taken out, suffered to drain, and then rinsed in running water; this manipulation softens the wool, and gives it the first degree of whiteness; it is then repeated a second, and even a third time, after which the wool is fit to be employed. In some places scouring is performed with water slightly impregnated with soap; and, indeed, for valuable articles, this process is preferable, but too expensive for articles of less value. Sulphurous acid gas unites very easily with water, and in this combination it may be employed for bleaching wool or silk.

The most economical way of preparing sulphurous acid, is by decomposing the acid, by the mixture of any combustible matter, capable of taking from it any part of its oxygen. When the chemist is desirous to have it in great purity, it is obtained by means of metallic substances, and particularly by mercury, but for the purpose of which we are treating, where great economy is required we should recommend most common substances. Take chopped straw, or saw dust, and introduce it into a matrass; pour over it sulphuric acid, applying at the same time heat, and there will be disengaged sulphurous acid gas, which may be combined with water in an apparatus. The pieces are rolled upon reels, and are drawn through the acid by turning them until sufficiently white. They are then taken out and left to drain on a bench covered with cloth, lest they should be stained in consequence of the decomposition of the wool by the sulphurous acid; they are then washed in river water, and Spanish white is employed, if it should be judged necessary. This operation is performed by passing the pieces through a tub of clean water, in which about eight pounds of Spanish white has been dissolved. To obtain a fine whiteness, the stuffs are generally twice sulphured. According to this process, one immersion, and reeling two or three hours, are sufficient. Azuring or bluing is performed by throwing into the Spanish white liquor, a solution of one part Prussian blue to four hundred of water; shaking the cloth in the liquid and reeling rapidly. The opera-

tion is terminated by a slight washing with soap, to give softness and pliability to the stuffs.

A preparation of an improved bleaching liquor is prepared as follows: by a dissolution in water of the oxygenated muriates of calcareous earths, barytes, strontites, or magnesia. The earth should be prepared in the dry way, by bringing them in a solid form, in powder, or in paste, in contact with the oxygenated muriatic acid gas. So prepared, dissolve them in water, and apply them to the substances required to be bleached. By this mode, colours may be removed from linen, cotton, vegetable and other substances.

*Bleaching Salts, used in Manufactories.* Pass into water, in which finely pulverized and newly slacked lime is suspended by continual agitation—a stream of oxymuriatic acid gas will come over. In the large way, a dry powder of newly slacked lime is agitated in a strong cask, which is absorbed by lime. Some prefer passing the gas into hogsheads of water, in which the lime is suspended by agitation; for an experiment it may be pressed from a bladder may be held in the hand, and the receiver shaken continually.

*To bleach Straw, &c.* Cover the bottom of a small plate a quarter of an inch deep with water. Put a small piece of common brimstone upon a sheet iron bench set in the plate, which is sufficiently heated to inflame the brimstone, and shut it over a tubulated bell glass, or a tumbler with a hole in the bottom. This vessel must be of a size just to shut down within the rim of the plate. At first take the stopper out and raise the bell glass a little above the water, to give passage to a current of air. Regulate this by the progress of the burning sulphur. After the bell glass appears well filled with a white vapour, shut it down close and tighten the stopper. The water in the plate will absorb the sulphurous acid gas in about five minutes. Pour part of this water into wine glasses, and you will perceive the nauseous, sulphurous, astringent taste, peculiar to this acid. In the mean time wet several substances, coloured with vegetable colouring matter, and it will extinguish many of them if not all. A yellow straw braid becomes whitened in it; and some colours on calico will be extinguished. The liquid sulphurous acid loses this property by keeping.

It is used by milliners both in the liquid and in the gaseous state for bleaching straw bonnets. If the old straw braid is

soaked a while in water and then suspended inside of a hog's-head or barrel without a head, and brimstone is inflated at the bottom of a cask, and suffered to commence burning thoroughly, then the top covered over, the straw will soon become whitened by the action of this acid.

*To Whiten Wax.* Melt it in a pipkin without boiling. Then take a wooden pestle, which steep in the wax two inches deep and plunge immediately in cold water, to loosen the wax from it, which will come off like sheet of paper. When you have got all of your wax out of the pipkin, and make into flakes, put it on a clean towel, and expose it in air, on the grass, till it is white. Then melt it and strain it through a muslin, to take all the dust out of it, if there be any.

*Method of purifying Tallow to make Candles.* Take five eights of tallow and three eights of mutton suet; melt them in a copper caldron with half a pound of grease; as soon as they are melted, mix eight ounces of brandy, one salts of tartar, one cream of tartar, one sal ammoniac, and two of pure dry potash: throw the mixture into the caldron and make the ingredients boil a quarter of an hour; then let the whole cool. The next day the tallow will be found upon the surface of the water in a pure cake. Take it out and expose it to the action of the air, on canvass for several days. It will become white, and almost as hard as wax. The dew is very favourable to bleaching; make your wick of fine even cotton, give them a coat of welted wax; then cast your mould candles. They will have much the appearance of wax, and one of six to the pound, will burn fourteen hours and never run.

*To make Mutton Suet Candles in imitation of Wax Candles.* 1. Throw quicklime in melted mutton suet; the lime will fall to the bottom, and carry with it every impurity, so as to leave it pure and fine as wax itself.

2. Now if with one part of that suet you mix three of real wax, you will be unable to distinguish the mixture; even in the casting and moulding wax figures or ornaments.

## CHAPTER XXVIII.

*Distillation—to produce Inflammable Spirits—of Malt—of Hops—of water for Brewing—Brewing Vessels—what is procured by distillation—Bodies proper for distillation.*

By the distillation of spirits is to be understood the art by



which all inflammable spirits, brandies, rum, arracs, and the like, are procured from vegetable substances, by the means of a previous fermentation, and a subsequent treatment of the fermented liquor by the alembic or hot still, with its proper worm and refrigeratory. But as it is impossible to extract vinous spirits from any vegetable subject without fermentation, and previous to this, brewing is often necessary, it will be requisite to consider these operations.

To extract spirits is to cause such an action by heat, as to cause them to ascend in vapour from the bodies which detain them. If this heat be natural to bodies, so that the operation be made without any adventitious means, it is called fermentation, which will be hereafter explained; if it be produced by fire or other heating power in which the alembic is placed, it is called digestion, or distillation; digestion, if the heat only prepares the materials for distillation of their spirits; and distillation when the action is of sufficient efficacy to cause them to ascend in vapour and distil. This heat is that which puts the insensible parts of a body, whatever it be, into motion, divides them, and causes a passage for the spirits enclosed herein, by disengaging them from the phlegm, and the earthy particles by which they are enclosed. Distillation considered in this point is not unworthy the attention and countenance of the learned. This art is of infinite extent: whatever the whole earth produces, flowers, fruits, seeds, spices, aromatic and vulnerary plants, odoriferous drugs, &c. are its objects, and come under its cognizance; but it is generally confined to liquids of taste and smell, and to the simple and spirituous waters of aromatic and vulnerary plants: with regard to its utility, we shall omit saying any thing here, as sufficient proofs of it will be given in some of the articles respecting it.

*Of Brewing in order to the Production of Inflammable Spirits.* By brewing is meant the extracting a tincture from some vegetable substance, or dissolving it in hot water, by which means it becomes proper for a vinous fermentation; a solution or fermentable tincture of this kind may be procured, with proper management, from any vegetable substance, but the more readily and totally it dissolves in the fluid, the better it is fitted for fermentation, and the larger its produce of spirits. All inspissated vegetable juices therefore, as sugar, honey, treacle, manna, &c. are very proper for this use, as

they totally dissolve in water, forming a clear and uniform solution; but malt, from its cheapness, is generally preferred in England; though it but imperfectly dissolves in hot water. The worst sort is commonly chosen for this purpose, and the tincture without the addition of hops, or the trouble of boiling it, is directly cooled and fermented. But in order to brew with malt to the greatest advantage, the three following particulars should be carefully attended to: 1. The subject should be well prepared, that is, it should be justly malted and well ground: for if it be too little malted, it will prove hard and stinty, and consequently, only a small part of it dissolve in the water, and on the other hand, if too much malted a great part of the finer particles or fermentable matter will be lost in the operation. With regard to grinding, the malt should be reduced to a kind of coarse meal, for experience has shown, that by this means the whole substance of the malt may, through the whole process, continue mixed with the tincture, and be distilled with it; whereby a larger quantity of spirit will be obtained, and also great part of the trouble, time and expense in brewing saved. This secret depends upon thoroughly mixing or briskly agitating the meal, first in cold water, and then in hot, and repeating the agitation after the fermentation is finished, when the thick turbid wash must be immediately committed to the still. And thus the two operations of brewing and fermenting may very commodiously be reduced to one, to the great advantage of the distiller. The second particular to be attended to, is that the water be good, and properly applied. Rain water is the best adapted to brewing, for it not only extracts this tincture of the malt better than any other, but it also abounds in fermentable parts whereby the operation is quickened, and the yield of the spirit increased. The next to that of rain, is the water of rivers and lakes, particularly such as wash any large tract of a fertile country, or receive the sillage of populous towns. But what ever water is used, it must stand in a hot state upon the prepared malt, especially if judicious distillers, should always take care to have their wash sufficiently dilluted, they would find their spirits the purer for it.

With regard to the fire, it may be easily kept regular, by a constant attendance, and observing never to stir it hastily, or throw on fresh fuel; and the stirring the liquor in the still is to be effected by means of a paddle, or bar kept in the liquor,

till it just begins to boil, which is the time for luting on the head, and after which there is no great danger, but from the improper management of the fire; this is the common way; but it is no easy matter to hit the exact time; and the doing of it, either too late or too soon, is attended with great inconvenience, so that several have discovered other methods, some put more solid bodies into the still, with the wash; others place some proper matter at the bottom and sides of the still, which are the places where the fire acts with the greatest force. The use of the paddle, would however, answer better than either of these methods, could it be continued during the whole time the still is working; and this may be done by the following method; let a short tube of iron or copper be soldered in the centre of the still head, and let a cross bar be placed below in the same head, with a hole in the middle corresponding to that at the top; through both these, let an iron pipe be carried down in the still, and let an iron rod be passed through this, with wooden sweeps at its end; this rod may be continually worked by a wrench at the still head, and the sweeps will continually keep the bottom and sides scraped clean, the interstices of the tube being all the time well crammed with tow, to prevent any evaporation of the spirit. The same effect may in a great measure be produced, by a less laborious method, namely, by placing a parcel of cylindrical sticks lengthwise, so as to cover the whole bottom of the still, or by throwing in a loose parcel of faggot sticks at a venture, for the action of the fire below moving the liquor, at the same time gives motion to the sticks, making them act continually like a parcel of stirrers upon the bottom and sides of the still, which might if necessary be furnished with buttons and loops, to prevent them from starting. Some also use a parcel of fine hay laid upon the loose sticks, and secured down by two cross poles, laid from side to side, and in the same manner fastened down with loops. Care is to be taken in this case not to press the hay against the sides of the still, for that would scratch nearly as soon as the wash itself; but the sticks never will; these are simple but effectual contrivances, and in point of elegance, they may be improved at leisure.

There is another inconvenience attending the distillation of malt spirit, which is, when all the bottoms or gross mealy feculence is put into the still along with the liquor, the thinner

part of the wash going off in the form of spirit, the mealy mass grows by degrees, more and more stiff, so as to scorch towards the latter part of the operation; the best method of remedying this, is to have a pipe, with a stop cock, leading from the upper part of the worm tub into the still, so that upon a half or a quarter turn, it may continually supply a little stream of hot water, in the same proportion as the spirit runs off, by which means the danger of scorching is avoided, and the operation at the same time, not in the least retarded.

In Holland, the malt distillers work all their wash thick, with the whole body of meal among it, yet they are so careful in keeping their stills clean, and so regular and nice in the management of their fires, that though they use no artifice at all on this head, only to charge the still, while it is hot and moist, they very rarely have the misfortune to scorch, except now and then in the depth of winter. When such an accident has once happened in a still, they are very careful to scrape, scrub and scour off the remains of the burnt matter, otherwise they find the same accident liable to happen again in the same place. But beyond all other methods in use on this occasion, would be the working the stills, not by a dry heat, but in a *balneum mariæ*, which might be possibly contrived by the basin being large and capable of working a great many stills at once, so as to be extremely worth the proprietor's attention in all respects. Another requisite to be observed is, that the water in the worm tub be kept cool; this may be effected by placing in the middle of the tub a wooden pipe or gutter, about three inches square within, reaching from the top nearly to the bottom. By this contrivance cold water may, as often as necessary, be conveyed to the bottom of the warm tub, and the hot water at the top forced either over the sides of the tub, or, what is better, through a leaden pipe of a moderate size, called a waste pipe, soldered into the top of the tub, and extended to the gutter formed to carry away the water.

*To choose good Malt.* Malt is chosen by its sweet smell, mellow taste, full flower, round body and thin skin; there are two sorts in general use, the pale and the brown. The former is more generally used in gentlemen's houses and private families, the latter in public brew houses, as seeming to go further, and make the liquor higher coloured. Others again mix one third brown with two thirds pale; but this depends

upon the liking of the drinkers. The sweetest malt is that which is dried with coak or cinders. In grinding it, see that the mill be clean from dust, cobwebs, &c. Set it so as to crush every grain, without grinding it to powder; for you had better have some small grains slip through untouched, than to have the whole ground too small, which will cause it to take together, so that you cannot get the goodness out of it.

*Hops.* Hops are chosen by their bright green colour, sweet smell and clamminess when rubbed between the hands.

*Water for Brewing.* Water out of rivers or rivulets is best, except polluted by the melting of snow or land water from clay on ploughed lands. Snow water will take near one-fifth part more of malt to make the beer good. If you have no river water, a pond that has a bottom not over muddy, and is fed by a spring, will do; for the sun will soften and rarify it. Very hard water drawn from a deep well into a wide cistern or reservoir, and exposed to the air or sun, in two or three days has been brewed with success, by the addition of malt. Rain water comes next to river for brewing. In short, all water that will raise a lather with soap, is good for brewing.

*Brewing Vessels.* To a copper that holds thirty-six gallons, the mash tun ought to be at least large enough to contain six bushels of malt, and the copper of liquor, and room for mashing or stirring it. The under back coolers and working tuns, may be rather fitted to the convenience of the room, than to a particular size, for if one vessel be not sufficient to hold your liquor, you may take a second.

*Of what is procured by Distillation.* By distillation are procured spirits, essence, simple waters, and phlegm. Spirits are very difficult to be defined. We consider them as the most subtile and volatile parts of a body. All bodies, without exception have more or less spirits. These parts are an ignited substance, and consequently by their own nature disposed to violent motion. These volatile particles are more or less disposed to separate themselves as the bodies are more or less porous, or abound with a greater or less quantity of oil. By the term essence, we understand the oleaginous parts of a body. An essential oil is found in all bodies, being one of their constituent principles. We have observed in all distillations, spirits of wine excepted, a soft unctuous substance floating on the phlegm; and this substance is oil,

which we call essence, and this is what we endeavour to extract. Simple waters are those distilled from plants, flowers, &c. without the help of water, brandy, or spirits of wine. These waters are commonly odoriferous, containing the odour of the body from whence it is extracted, and even exceeds in smell the body itself. Phlegm is the aqueous particles of bodies, but whether an active or passive principle, we shall leave to the decision of chemists. It is of the last importance to a distiller to be well acquainted with its nature. Many mistaking for phlegm, several white and coloured drops, which first fall into the receiver, when the still begins to work. These however are often the most spirituous particles of the matter in the alembic, and consequently ought to be preserved. What has given occasion to this mistake, is some humidity remaining in the head, &c. of the alembic. And had it been thoroughly wiped, the first drops would have been equally bright with any, during the whole operation.

The following remark deserves attention. In bodies that have been digested, the spirits ascend first. Whereas in charges not digested, the phlegm ascends before the spirits. The reason of this is very plain and natural. In substances previously digested, the action of fire no sooner causes the matter in the alembic to boil, than the spirits, being the most volatile parts, detach themselves, and ascend into the head of the alembic. But when the matter to be distilled has not undergone a proper digestion, the spirits being entangled in the phlegm, are less disposed to ascend till the phlegm itself separates and gives them room to fly upwards. The phlegm being aqueous, rises first—this is more particularly observable in spices. We are, however, inclined to believe, that were the operation performed in an alembic, when the head was at a great distance from the surface of the charge, they would not ascend high enough to come over the helm, but fall back again by their own gravity, and by that means leave the spirits at liberty to ascend. But in the common refrigeratory alembic this always happens. If this observation be not readily admitted, we appeal to experience, which we desire may be the test of every thing we advance. Another observation which has verified the above assertion by innumerable instances is, that when we have not time sufficient to digest the substances, we should bruise them in a mortar; but notwithstanding the trituration, the phlegm will first come over

and afterwards the spirits. But we desire to be understood, that we speak here only of the volatile parts of the plants, not drawn with vinous spirits, but contained in a simple water.

Another remark we must add, and which we hope will be acceptable to the curious, as it has not yet been made public, though doubtless the observation has often occurred to others; it is this: that in mixed charges, consisting of flowers, fruits, and aromatic plants put into the alembic, without any previous digestion, the spirits of the flowers ascend first; and notwithstanding the mixture, they contract nothing of the smell or taste of the fruits and plants. Next after the spirits of the flowers, those of the fruits ascend, not in the least impregnated with the smell or taste of either of the flowers or plants. And in the last place the spirits of the plants distil no less neat than the former. Should this appear strange to any one, experience will convince him of the truth. Another observation we have made on aromatic herbs, is, that whether they are or are not digested, or if the spirits or phlegm ascend first, the spirits contain very little of the taste or smell of the plants from whence they were extracted; and we have always been obliged to put to these spirits a greater or less quantity of the phlegm, in order to give the spirits we had drawn, the taste of an aromatic odour of the plants, the phlegm containing the greatest quantity of both. This observation we insert as of great use to those who practice distillation.

As the term digestion often occurs in this essay, we cannot avoid pointing out its advantages, and even show the necessity of using it in several circumstances. Substances are said to be in digestion when they are infused in a menstruum over a very slow fire. This preparation is often necessary in distillation, for it tends to open the bodies, and thereby free the spirits from their confinements, whereby they are better enabled to ascend. Cold digestions are the best; those made by fire, or in hot materials, diminish the quality of the goods, or some part, as the most volatile will be lost. In order to procure essences, the bodies must be prepared by digestion. It is even of absolute necessity for extracting the spirits and essences of spices.

*Bodies proper for Distillation.* This article alone might make a volume, were a particular enumeration of all its parts

made ; but as it has been already observed, we shall confine ourselves to the distillation of simple and compound waters. If we acquit ourselves to the satisfaction of the public, we shall enjoy the pleasure of having treated on one part entirely new : and the only one, indeed that has been overlooked. The bodies proper for distillation, are flowers, fruits, seeds, spices and aromatic plants. By distillation and digestion, we extract the colour and smell of flowers, in simple waters and essences. We extract from fruits, at least from some, colour, taste, &c. From aromatic plants the distiller draws spirits, essences, simple and compound waters. From spices are procured essences, or in the language of the chemist, oils and perfumes, and also pure spirits. From seeds or berries are drawn simple waters, pure spirits, and from some, as those of anise, fennel and juniper, oil. The colour of flowers is extracted by infusion and likewise by digestion in brandy or spirits of wine ; the smell is extracted by distillation ; the simple water with brandy or spirits of wine. What is extracted of the colour of flowers by infusion in water, by a gentle heat or by digestion in brandy or spirits of wine, is called, in the distiller's phrase, tincture of flowers. The colour of fruits is extracted in the same manner, either by infusion or digestion, their taste is also procured by the same processes. But let it be observed that the time of these operations must be limited ; for otherwise the fruit, after fermentation, would render it acid. The taste is also extracted by the alembic, pure spirits, odours, simple waters, but these require different methods of distillation. The first by water or brandy only, the second by rectified spirit, which will give them the greatest excellency they are capable of receiving.

The plants themselves with their flowers may also be distilled, which is still better. From spices are drawn spirits and oily or spirituous quintessences. The spirits are drawn by brandy, or spirits of wine, with very little water ; the oils are distilled *per descensum* : and the spirituous quintessences by pounding the spices, and after infusing them in spirits of wine, decanting it gently by inclination. From seeds are extracted simple waters, spirits and oils. Very few of the first and last spirits being what is generally extracted from seeds and berries. Some distillers, through a notion of frugality, distil seeds with water, but their liquors are not to be compared with those which are distilled with spirits. When



oils are drawn from seed, the operation is performed either by the *balneum mariæ*, or vapour bath.

## CHAPTER XXIX

### *Fermentation—Rectification—Filtration.*

*Fermentation.* The tincture, or the wash, as distillers call it, being prepared as you will find described under the head of *Brewing in order to the production of inflammable spirits*, it is next to be fermented; for without the operation no vinous spirit can be produced. By fermentation is meant that intestine motion performed by the instrumental efficacy of water, whereby the salt, oil, and earth of a fermentable subject are separated, attenuated, transposed, and again collected, and recomposed in a particular manner. The doctrine of fermentation is of the greatest use, and should be well understood by every distiller, as it is the very basis of the art, and perhaps, if more attended to, a much purer spirit, as well as a greater quantity of it might be procured, from the same materials than at present. We shall therefore lay down a concise theory of fermentation, before we proceed to deliver the practice.

Every fermentable subject is composed of salt, oil, and a subtile earth; but these particles are so small, that when asunder, they are imperceptible to the senses; and therefore, when mixed with an aqueous fluid, they leave it transparent; neither have fermentable bodies any taste, except that of sweetness. These particles are composed of salt, oil and earth, intimately mixed in an actual cohesion, connexion and union; and therefore, when any one of these principles too much abounds in any subject, so that an intimate union is prevented, the whole efficacy of the fermentation is either stopped or impaired, or at least limited to one certain species. This equal connexion of salt, oil and earth, into a single compound particle, forms a corpuscle, soluble in water; or to speak more philosophically, this compound corpuscle is, by means of its saline particles, connected with the aqueous corpuscles, and moved up and down with them. But when these corpuscles are not thus connected with the water, a number of them join together, and form either a gross or a loose chaffy and spongy matter. When these compound particles are diluted with a small quantity of aqueous fluid, they feel slippery, clammy, and unctuous to the touch, and effect the taste with a kind of rosy sweetness, and when a proper quantity of the

fluid is added, a commotion is presently excited, and afterwards a subtle separation first begins in the whole substance, for before the addition of water, the subject may remain in dry, solid, and large pieces, as in malt, sugar, &c. which being reduced to powder, each grain thereof is an agreement of many compound corpuscles; then being put into water, dissolve and separately float therein, till at length they become so small as to be invisible, and only thicken the consistence of the liquor.

These corpuscles being thus separated from one another, there next ensues a separation of their component particles; that is, the salt, the oil and the earth are divided by the interposition of aqueous particles. The first commotion is no more than a bare solution; for the saline particles being easily dissolvable in water, they are immediately laid hold of by the aqueous particles, and carried about with them. But the succeeding separation or fermentative motion is a very different thing; for by this, the saline particles are divided from those of oil and earth, partly by the impulse of the others in their motion, and partly by the force of the aqueous particles, which are now continually meeting and dashing against them. This motion is performed by the water, as a fluid or aggregate of an infinite number of particles in actual and perpetual motion, their smallness being proportionable to that of the fermenting corpuscles, and their motion, or constant susceptibility of motion, by the warmth and motion of the air, disposing them to move other subtle moveable corpuscles also. The certain agreement of figure or size, between the aqueous particles, and those of the salt in the fermentable subject, tends greatly to increase this commotion: for by this means they are readily and very closely connected together; and move almost like one and the same compound corpuscle, while the water is not at all disposed to cohere immediately with either the oil or earth; and thus an equal concussion is excited in the compound corpuscles of the fermentable subject which concussion at length strikes out the saline particles, loosens the others, and finally produces a separation of the original connexion of the subject.

An aqueous fluid, therefore, is the true, and indeed the only instrument for procuring a fermentable motion in these compound corpuscles of the subject, for were an oily fluid poured upon any fermentable subject, no vinous fermentation

would ensue ; as the oil could neither give a sufficient impulse on the compound corpuscles which are grosser than its own constituent particles, nor divide the oily or saline particles of the subject, from their connexion with the others, which detain, and as it were, envelope or defend them from its action. The compound corpuscles of the fermentable subject being affected by the perpetual motion of the particles of the aqueous fluid, a proper degree of motion is necessary, or that the particles move with a proper degree of velocity, which depends on external heat. A considerable degree of cold, indeed, will not absolutely prevent fermentation, though it will retard it ; and a boiling heat will prevent it still more. A tepid or middle degree of heat, between freezing and boiling is therefore the most proper for promoting and quickening the operation. The admission of air, also, though not of absolute necessity, yet greatly promotes and quickens the action, as being a capital instrument in putting in a proper degree of motion the oily particles of the subject ; but whilst the air thus contributes to hasten the effect, it causes at the same time by its activity, some remarkable alterations in the oily particles ; for it not only moves but absolutely dissolves and displaces them from their original connexions ; and thus carries them off itself from the whole mass. And, therefore, though the consideration of the air does not so properly belong to fermentation in general, yet it does in particular cases ; as having an accidental power to alter every species of this operation, consequently its agency ought to be well understood, either to procure alterations at pleasure, in the fermenting mass, or to prevent or correct impending dangers. The oily particles thus separated and dissolved by the air, are also elastic, though they probably derive that property from their intercourse with the air itself, and these being rendered extremely minute. When, therefore, an aqueous fluid is added to a fermentable subject, exposed to a temperate heat, a fermentative struggle immediately arises, the saline part of the compound particles being dissolved by the continual intestine motion of the water, and carried up and down with it in all directions, amidst an infinite number of other particles, as well fermentable as aqueous ones, whence by this collision and attrition, the saline particles are dissolved and separated from their connexion with the oily and earthy. And as the oily particles are the most subtile and elastic, they would by

this means, be thrown up to the surface of the liquor, and carried off by the air, were they not closely connected with the earthy ones, whose gravity prevents their evaporation, and by coming in contact with others of the same kind, form aggregations, and sink down with the oily particles to the bottom.

But before these can form a bulk too large to be supported by the water, many of the oily particles are, by their frequent collisions with the aqueous fluid, separated from the earthy ones, and by degrees more strongly connected again with the saline ones; whilst on the other hand, the same saline particles imbibe some of the earthy ones, which being left single upon their separation from the oily particles, float about separately in the fluid. And hence proceed the several different consequences of fermentation; namely, 1. From the separation of the saline particles of the fermentable subject, proceeds the tart, saline or acid taste of the liquor which is more sensible at first, before the liquor is duly composed and settled, or the due arrangement and connexion of the saline particles with those of the oily and earthy kinds, completed; after which the liquor becomes milder, softer or less pungent. 2. From the oily particles being set at liberty, proceeds the strong smell of the liquor, and the head or shining skin upon the surface. 3. The earthy particles collecting together in clusters, cause the fluid to appear turbid, and afterwards a visible, earthy or clay like matter, to be precipitated; and some of the earthy parts in their motion, arriving at the head or oily skin on the surface cause it to thicken, and afterwards taking it down along with it, thus constitute the lees which abound in oil. 4. From this new struggle or collision, which is productive both of solution and a new connexion in the saline and earthly corpuscles, proceeds the ebullition in fermentation; and lastly, by the same repeated coalition of the oily with the aqueous and saline particles, the inflammable spirit is produced.

Having thus laid down a concise theory of fermentation, we shall now proceed to the practice. The wash being brought to a tepid or luke-warm state in the backs, a proper quantity of a good conditioned ferment is added; but if the ferment be soiled, it should be previously broke into small pieces, and gently thinned, either with the hand, wisp, &c. in a little of the tepid liquor. A complete and uniform solution,

should not be attempted, because that would greatly weaken the power of the ferment, or destroy its future efficacy. The whole intended quantity being thus loosely mixed with a moderate portion of the liquor, and kept in a tepid state, either by setting it near the fire or otherwise, and free from the too rude commerce of the external air, more of the insensibly warm liquor ought to be added at proper intervals, till at length the whole quantity is properly set to working together, and thus by dividing the business into parts, it may much more speedily and effectually be performed, than by attempting it all at once.— The whole quantity of liquor being thus set at work, secured in a proper degree of warmth, and defended from a too free intercourse of the external air, nature itself, as it were, finishes the process, and renders the liquor fit for the still. By ferments is meant any substance, which being added to any rightly disposed fermentable liquor, will cause it to ferment much sooner and faster, than it would of itself, and consequently render the operation shorter, in contradiction to those abusively called so, which only corrects some fault in the liquor, or gives it some flavour. Hence, we see, that the principle use of ferments is to save time, and make despatch in business, whilst they only occasionally, and as it were by accident give a flavour and increase the quantity of spirits.— And accordingly, every fermentable spirit may without the addition of any ferment, by a proper management of heat alone, be brought to ferment, and even more perfectly, though much slower than with their assistance. These ferments are in general the flowers and fæces of all fermentable liquors, generated and thrown to the surface, or deposited at the bottom, either during the act of fermentation or after the operation is finished. Two of these are procurable in large quantities, and at a small expense: beer yeast and wine lees; a prudent and artificial management, or use of which might render the business of distillation, much more certain and advantageous. It has been esteemed very difficult and a great discouragement in the business of distillation, to procure a sufficient stock of these materials, and preserve them at all times ready for use. The whole secret consists in dexterously freeing the matter from its superfluous moisture; because in its fluid state, it is subject to a further fermentation, which is productive of corruption, in which state it becomes intolerably foetid and cadaverous. The method of exposing it to

the air till it has acquired a proper consistence, is subject to great inconveniences; and so peculiar and careful management is necessary, that it rarely succeeds. The best way therefore, is to press it very slowly and gradually, in a thick, close and strong canvas bag, after the manner of wine lees; by the toil press, till it becomes a kind of cake, which though soft, will easily snap, or break between the fingers. Being reduced to that consistence, and closely packed up in a tight cask, it will remain a long time uncorrupted, preserve its fragrance, and consequently fit to be used for fermenting the finest liquor.

The same method is also practicable and to the same advantage, in the flowers of yeast or wine, which may be thus commodiously imported from abroad; or if these cannot be procured, others of equal efficacy may be procured from fresh wine lees, by barely mixing and stirring them into a proper warm liquor, when the lighter and more volatile and active parts of the lees will be thrown to the surface, and may easily be taken off and preserved by the above mentioned method, in any desired quantity. And hence, by a very easy process an inexhaustible supply of the most useful ferments may be readily and successively procured, so as to prevent for the future, all occasion of complaint for the want of them, in the distiller's business. Experience has demonstrated, that all ferments abound much more in essentials, than the liquor which produced them; and consequently, they retain in a very high degree, the smell and flavour of the subject. It is therefore requisite, before the ferment is applied, to consider what flavour is introduced, or what species of ferment is most proper for the liquor. The alteration thus caused by ferments, is so considerable as to render any neutral fermentable liquor of the same flavour of that which yields the ferment. This observation is of much greater moment than will readily be conceived, for a new scene is hereby opened, both in the business of distillation, and others depending upon fermentation. It must, however, be observed, that its benefit does not extend to malt treated in the common method; nor to any other subject but what affords a spirit tolerably pure and tasteless. For otherwise, instead of producing a simple, pure and uniform flavour, it causes a compound, mixed and unnatural one. How far the fine distiller may profit by it, well deserves his attention, and whether our native cider spirit, crab

spirit, &c. which have very little flavour of their own, may not by this artifice, be brought nearly, if not entirely, into the state of some foreign brandies, so highly esteemed, is recommended to experience. It is common with distillers, in order to increase the quantity of spirit, to give it a particular flavour, to improve its vinosity, to add several things to the liquor during the time it is in a state of fermentation, and these additions may properly be reduced to salts, acids, aromatics, and oils.

All rich vegetable juices, as treacle, honey, &c. which either want a natural acid, have been deprived of it, or contain it in too small a quantity, will be greatly improved by adding at the beginning of the operation, a small quantity of the vegetable or fine mineral acid; as oil of sulphur, gloubers, spirit of salt, juice of lemon, or an aqueous solution of tartar. These additions will either give, or greatly improve the vinous acidity of the subject, but not increase the quantity of the spirits; that intension being performed by aromatics and oils. All pungent aromatics have a surprising quality of increasing the quantity of the spirits, as well as in altering or improving the flavour; but their use requires that the fermentation should be performed in close vessels, and if a large quantity be intended to be added, care must be taken not to do it all at once, lest the oiliness of the ingredients should check the operation. But if the flavour be the principal intension, they should not be added till the operation is nearly finished. After the same manner a very considerable quantity of any essential vegetable oil may be converted into a surprisingly large quantity of inflammable spirits; but great caution is here also necessary, not to drop it too fast, or add too large a quantity at a time, which would damp the fermentation, it being the surest method of checking, or to ally stopping this operation at any point of time required. The best method therefore, of adding the oil so as to avoid all inconveniences, is to rub the oil in a mortar with sugar, which the chemists call making an *olæ-saccharum*, by which means the tenacity of the oil will be destroyed; and the whole readily mix with the liquor, and immediately ferment with it. The distiller would do well to consider these observations attentively, as he may thence form an advantageous method of increasing the quantity of spirits, and at the same time greatly improve their quality and flavour. But in order to put these observa-

tions in practice, particular regard must be had to the containing vessel in which the fermentation is performed, the exclusion of the air, and the degree of the external heat or cold. With regard to the containing vessel, its purity, and the provision for rendering it occasionally close, are chiefly to be considered. In cleansing it, no soap or other unctuous body should be used, for fear of checking the fermentation; and for the same reason, all strong alkaline lixivium should be avoided. Limewater, or a turbid solution of quicklime may be employed for this purpose, without producing any ill effect: it will also be of great service in destroying a prevailing acetous salt, which is apt to generate in the vessels when the warm air has free access to them; and tends to prevent the order of fermentation, and instead of a wine or wash, produce a vinegar. Special care must also be had that no remains of yeast, or cadaverous remains of former fermented matters hang about the vessels; which would infect whatever should be afterwards put into them, and cannot, without the utmost difficulty, be perfectly sweetened and cured. The occasional closeness of the vessels may, in the large way, be provided for by covers properly adapted; and in the small way, by valves placed in light casks. These valves will occasionally give the necessary vent to preserve the vessel, during the height of the fermentation; the vessel otherwise remaining perfectly close, and impervious to the air. It is a mistake of a very prejudicial nature in the business of fermentation, to suppose that there is an absolute necessity for a free admission of the external air: the express contrary is the truth, and very great advantages will be found by practising according to this supposition. A constant influx of the external air, if it does not carry off some part of the spirit already generated, yet certainly catches up and dissipates the fine subtile or oleaginous and saline particles, whereof the spirit is made, and thus considerably lessens the quantity. By a close fermentation, this inconvenience is avoided; all air except that included in the vessel, being excluded. The whole secret consists in leaving a moderate space for the air at the top of the vessel unpossessed by the liquor; when the liquor is once fairly at work, to bung it down close, and thus suffered to finish the fermentation without opening or giving it any more vent than that afforded it by a proper valve placed in the cask, which however, is not of absolute neces-



sity, when the empty space, or rather that possessed by the air, is about one tenth of the guage; the artificial air, generated in the operation, being then seldom sufficient to open a strong valve, or at most not to endanger the cask. This method may be practised to great advantage by those whose business is not very large; but it requires too much time to be used by the large dealers, who are in a manner forced to admit the free air, and thus sustain a considerable loss in their quantity of spirits, that the fermentation may be finished in the small time allowed for that purpose. It may however be said, that the silent, slow, and almost imperceptible vinous fermentation, is universally the most perfect and advantageous. During the whole course of this operation, the vessel should be kept from all external cold, or considerable heat, in an equal, uniform, and moderate temperature. In the winter, stove rooms, such as are common in Germany would be very convenient for this purpose, the vessel being placed at a proper distance from the stove; but at other seasons no particular apparatus is necessary in England, or even in the central part of the United States, if the place allowed for the business be but well defended from the summer's heat and the ill effects of cold, bleak, northern winds. The operation is known to be perfect when the hissing, or small bubbling noise can be no longer heard upon applying the ear to the vessel; and also, by the liquor itself appearing clear to the eye, and having a pungent sharpness on the tongue. And that it may fully obtain these properties and be well fitted to yield a pure and perfectly vinous spirit by distillation, it should be suffered to stand at rest in a somewhat cooler place, if practicable, than that in which it was fermented, till it has thoroughly deposited, and cleansed itself of the gross-lee, and become perfectly transparent, vinous and fragrant, in which state it should be committed to the still; and the spirits obtained will not only exceed that obtained in the common way in quantity, but also in fragrance, pungency and vinosity.

*Rectification.* The principal business is to separate the spirit from the essential oil the spirit contains. Care should be taken in the first distillation; the spirit, especially malt spirit should be drawn by a gentle fire, which will keep a great part of the essential oil from mixing with the spirit, as it is abundantly proved easier to keep asunder than to separate

when mixed, as this is almost impossible. To draw low wines the best method of separating the oil from the spirit is by redistillation and percolation. To rectify low wines, they should be put into a tall body, or alembic, and gently distilled in *balneum mariæ*; by this means both the oil and the phlegm will remain in the body, but if the spirit should be found after this operation, to contain some of the essential oil, it must be let down with fair water and re-distilled in the same manner. And thus it may be brought to any degree of purity, especially if in working, the spirit be suffered to fall into a proper quantity of the *balneum mariæ*. - But it must be remembered, that it is much more difficult to cleanse alcohol or proof spirit, than low wines, because the oil is more intimately mixed with the two former than with the latter; this oil may however be separated from proof spirit, &c. by the method already proposed, especially if it be previously filtrated through paper, thick flannel, sand, stone, &c. But this method, though it effectually answers the intention, is generally rejected by distillers, because of the slowness of the operation, and others substituted in its stead; though instead of freeing the spirit from the oil, they only abolish the natural flavour of the spirit, and make a more intimate mixture between the particles of the spirit and those of the essential oil. It is impossible to enumerate all the methods practised by distillers, as almost every one pretends to have a secret nostrum for this purpose. The principal methods in use for rectifying malt spirits are however reducible to three, namely, by mixed alkaline salts, by acid spirits mixed with alkaline salts, and by saline bodies and flavouring additions. The method of rectifying by alkaline salts is thus performed. To every piece of proof spirit add fourteen pounds dry salt of tartar, fixed nitre, or calcined tartar; lute on the head, and distil by a gentle heat, but be careful to leave out the dregs. By this method a large proportion of the foul oil will be left in the still, and what comes over with the spirit will be greatly attenuated. But this operation is generally performed in a very different manner; for instead of distilling the spirit in a gentle and equable manner, the still is worked in its full force; by which means the oil, which should have remained in the still, is driven over and intimately mixed with the spirit, and consequently the whole operation frustrated, and the spirit rendered much harder to cleanse than it was before. But even when the operation is

performed according to the rules of art, it is far from being perfect, for it is well known that part of the fixed salts become volatile in the operation, passes over the helm, and intimately mixes with the essential oil still contained in the spirits; by this means the oil becomes more perfectly united with the spirits, and consequently much harder to be separated by repeated distillations: nor is this all; for the still being worked in its full force, the bitter oil of the malt formed into a kind of liquid soap in the still, by means of the alkaline salt, is brought over the helm with the faints and suffered to mix with the spirit, whereby it is rendered almost as nauseous and ill tasted as before the operation. Besides, if this operation were performed in its utmost perfection, it would never answer the intention, for the alkaline salts destroys the vinosity of the spirit, and consequently deprives it of one of its most valuable properties. Our distillers are well acquainted with this defect in the operation, and endeavour to supply it by an addition of acids. This is what we call the second method by alkalies and acids.

The operation of rectifying by the method of fixed alkalies and acids is the same as that above described: the spirit is drawn over from fixed alkalies as before, but in order to mortify the alkali in the spirit, and restore its vinosity, a proper quantity of some acid spirit is added. Various kinds of acids are used on this occasion, but principally those of the mineral kind, because of their cheapness; as the oil of vitriol, spirit of nitre, oil of sulphur, &c. We would however caution young distillers from being too busy with these corrosive acids. The sulphurous spirit of vitriol, dulcified spirit of nitre, or Mr. Boyle's acid spirit of wine will rectified well much better answer their purpose.

The third method of rectification, is that by saline bodies and flavouring ingredients. There is no difference in the operation, between this and the two foregoing methods: fixed alkaline salts, common salt depreciated, or dried calcined vitriol, sandiver, alum, &c. is put into the still with the low wines and the spirit drawn off as before. When the quantity is drawn off, the flavouring ingredients are added to give the spirit the flavour intended. But as the spirit is not by this means rendered sufficiently pure, the disagreeable flavour of the spirit generally overpowers that of the ingredients, whereby the whole intention is either destroyed, or a compound

flavour produced, very different from that intended. Some distillers, instead of alkaline salts, use quicklime in rectifying their malt spirit; this ingredient cleanses and depilegmatises the spirit considerably; but like that rectified from all alkaline salts, it requires an alkaline disposition, and also a rancidous flavour. Acids, therefore, are as necessary to be mixed with those spirits rectified with an alkaline salt. If chalk, calcined and well purified bones of animals, &c. were used instead of quicklime, the spirit would have much less alkaline or rancidous flavour; and consequently, the flavouring ingredients might be added to it with more success than can be expected from a spirit rectified from alkaline salts. But perhaps if neutral salts were used instead of the alkaline ones, the spirit might be rendered pure without contracting an alkaline flavour. Soluble tartar might be used for this purpose, though the spirit acquires as little saponaceous flavour.

Dr. Cox has mentioned another method for this purpose, namely, to deprive the volatile salts of their oil, by rendering them neutral with spirit of salt, and afterwards subliming them with salts of tartar. The acid may be varied if the spirit of salt should not be found so well adapted to the purpose as could be wished; but fine dry sugar seems the best adapted to the purpose of rectifying these spirits; as it readily unites with the essential oil, detains and fixes it, without imparting any urinous, alkaline or other nauseous flavour to the spirits rectified upon.

We shall conclude this article with remarking that there is no other method of rectifying to perfection, besides what is first laid down, viz. by gentle distillation: but then it must be remembered, that the whole process must be of a piece, viz. that the first distillation from the wash must be performed in a gentle manner, for otherwise the essential oil will be so intimately blended with the spirit as not to be easily separated by re-distillation. Another good property attending this method is its universality; all kind of spirits, from whatever ingredients extracted, require rectification; and this is adapted to all kinds.

*Of Filtration.* Filtration consists in passing liquors through a porous substance in order to free them from those particles which obscure their brightness. Nothing is finer than a liquor newly distilled, but the syrup and colouring particles, render it thick and opaque: in order therefore to restore

their brightness they are filtrated, which is done by passing them through silk, paper, cloth, &c. All the attention of the distiller in ordinary operations, cannot always prevent some aqueous particles from rising with the spirits, either in the beginning of the process, in those compositions where they ascend first, or at the conclusion when they rise last; as this is almost unavoidable, so it is sometimes necessary.

In distilling flowers, or aromatic plants, fresh gathered, the phlegm rises first; and this part cannot be taken out of the receiver, without depriving the spirits of a considerable part of their fragrancy.

In distilling spices, their odour being more entangled, will remain in the alembic, till part of the phlegm is drawn off. But when instead of these substances their quintessence is used, the necessity ceases. But the phlegm commonly causing a cloudiness in the liquor, it may be rendered tolerably fine by pouring it gently off by inclination, without the trouble of filtration; the aqueous particles, by their gravity, falling to the bottom; but to render it entirely bright and fine, put some cotton in a funnel, and pour the liquor through it, by which means the aqueous particles will be retained in the cotton. You must however remember to cover the top of the funnel, to prevent the most volatile parts of the spirits from evaporating.

## CHAPTER XXX.

### *Colouring Spirits—Imitation Spirits—Arometer.*

*Colouring Brandy.*—The art of colouring spirits owes its rise to observations on foreign brandies. A piece of French brandy that has acquired by age a great degree of softness and ripeness, is observed at the same time to have acquired a yellowish brown colour; and hence our distillers have endeavoured to imitate this colour in such spirits as are intended to pass for *French brandy*. A great variety of experiments have been made on various substances, to discover a direct and sure method of imitating the colour to perfection. To do this it is necessary to know from whence the French brandies themselves acquire their colour, for, till we have made this discovery, it will be in vain to attempt an imitation; because, if we should be able to imitate exactly the colour, which is indeed no difficult task, the spirit will not stand the test of different experiments, unless the colour in both be

produced from the same ingredient. This being undeniably the case, let us try to discover this mighty secret, the ingredient from whence the French brandy acquires its colour. We have already observed, that this colour is only found in such brandies as have acquired a mellow ripeness by age; it is therefore not given it by the distiller, but has gained it by lying long in the cask; consequently the ingredient from whence this colour is extracted, is no other than the wood of the cask, and the brandy in reality is become a dilute tincture of oak. The common experiment used to prove the genuineness of French brandy proves that this opinion is well founded. The experiment is this: they pour into a glass of brandy a few drops of a solution of calcined vitriol of iron in a diluted spirit of sulphur, or any other mineral acid, and the whole turns of a blue colour, in the same manner as we make ink of a tincture of galls and vitriol. Since, therefore, the colour of French brandies is acquired from the oak of the cask, it is not difficult to imitate it to perfection. A small quantity of the extract of oak or the shaving of that wood, properly digested, will furnish us with a tincture capable of giving the spirit any degree of colour required; but it must be remembered, that as the tincture is extracted from the cask by the brandy, and that this is alcohol and water, it is necessary to use both, in extracting the tincture, for each of these menstrua dissolve different parts of the wood. Let therefore, a sufficient quantity of oak shavings be digested in strong spirits wine and also, at the same time, other oak shavings be digested in oak, let both be poured off from the shavings into different vessels, and both placed over a gentle fire till reduced to the consistence of treacle. In this condition let the two extracts be intimately mixed together; which may be done effectually by adding a small quantity of loaf sugar, in fine powder, and well rubbing the whole together. By this means a liquid essential extract of oak will be procured, and always ready to be used as occasion shall require.

There are other methods in use for colouring brandies; but the best besides the extract of oak above mentioned, is burnt molasses and burnt sugar. The molasses gives the spirits a fine colour nearly resembling that of French brandies; but as its colour is but dilute, a large quantity must be used; this is not however attended with any bad consequences, for notwithstanding the spirit is really weakened by this addition,

though scarcely perceivable provided the molasses is well prepared, yet the bubble proof, the general criterion of spirits, is greatly mended by the tenacity imparted to them by the treacle. The spirit also acquires from this mixture, a sweetish or luscious taste and a fulness in the mouth, both of which properties render it very agreeable to the palates of the common people, who are in fact, the principal consumers of these spirits. A much smaller quantity of burnt sugar than of molasses will be sufficient for colouring the same quantity of spirits: the taste is also very different; for, instead of the sweetness imparted by the treacle, the spirit acquires from the burnt sugar, an agreeable bitterness, and by that means recommends itself to nicer palates, which are offended with a luscious spirit. The burnt sugar is prepared by dissolving a proper quantity of sugar in a little water, and scorching it over the fire till it acquires a black colour. Either of the above ingredients, molasses or burnt sugar, will nearly imitate the genuine colour of the French brandies, but neither of them will succeed when put to the test of the vitriolic solution.

To procure a colouring matter from molasses—place the vessel, either of tin, copper, or iron (an iron skellet will answer) containing the molasses, over coals, when it should be kept boiling until it becomes reduced by evaporation three fourths or more—during the process it should not be stirred, otherwise it will not become sufficiently scorched—a very material object.

*Imitation Brandy.* We have observed in the article on *rectification*, that the common method of rectifying spirits from alkaliine salts, destroys their vinosity, and in its stead introduces a fixivious taste. But as it is absolutely necessary to restore, or at least to substitute in their room, some degree of vinosity, several methods have been proposed, and a multitude of experiments performed, in order to discover this great desideratum: but none have succeeded equal to the spirits of nitre: and accordingly this spirit, either strong or dulcified, has been used by most distillers, to give an agreeable vinosity to their spirits. Several difficulties, however, occur in the method of using it, the principal of which is, its being apt to quit the liquor in a short time, and consequently depriving the liquor of that vinosity it was intended to give. To remove this difficulty, and prevent the vinosity from quitting the goods, the dulcified spirit of nitre, which is much better than the strong spirits, should be prepared by a previous digestion,

continued some time with alcohol; the longer the digestion is continued, the more intimately will they be blended, and the compound rendered the milder and softer. After a proper digestion, the dulcified spirit should be mixed with the brandy, by which means the vinosity will be intimately blended with the goods, and disposed not to fly off for a very considerable time. No general rule can be given for the quantity of this mineral acid requisite to be employed, because different proportions of it are necessary in different spirits. It should however, be carefully adverted to, that tho' a small quantity of it will undoubtedly give an agreeable vinosity resembling that naturally found in the fine subtile spirits drawn from wines, yet an over large dose of it, will not only cause a disagreeable flavour, but also render the whole design abortive, by discovering the imposition. Those therefore, who endeavor to cover a foul taste in goods by large doses of dulcified spirit of nitre, will find themselves deceived.

But the best, and indeed the only method of imitating French brandies to perfection, is, by an essential oil of wine; this being the very thing that gives the French brandies their flavour. It must however, be remembered, that in order to use this ingredient to advantage, a pure tasteless spirit must be first procured; for it is ridiculous to expect that this essential oil should be able to give the agreeable flavour of the French brandies, to our fulsome malt spirit, already loaded with its own nauseous oil, or strongly impregnated with a lixivious taste from the alkaline salts, used in rectification. How a pure insipid spirit may be obtained, will be found in the chapter on distillation. It only therefore remains to show the method of procuring the essential oil of wine, which is this. Take some cakes of dry wine lees, such as are used by hatters, dissolve them in six or eight times their weight of water, distil the liquor with a slow fire, and separate the oil by a separating glass; reserving for the nicest uses, that only which comes over first, the succeeding oil being coarser and more resinous.

Having procured this fine oil of wine, it may be mixed into a quintessence with pure alcohol; by which means it may be preserved a long time fully possessed of all its flavour and virtues; but without such management, it will soon grow resinous and rancid.

When a fine essential oil of wine is thus procured, and



also a pure and insipid spirit, French brandies may be imitated to perfection with regard to the flavor. It must, however, be remembered, and carefully adverted to, that the essential oil be drawn from the same sort of lees as the brandy to be imitated was procured from; we mean in order to imitate *cogniac* brandy, it will be necessary to distil the essential oil from *cogniac* lees; and the same for any other kind of brandy. For as different brandies, have different flavours, and these flavours are owing entirely to the essential oil of the grape, it would be preposterous to endeavor to imitate the flavour of *cogniac* brandy, with an essential oil procured from the lees of *Bordeaux* wine. When the flavour of the brandy is well imitated by a proper dose of the essential oil, and the whole reduced into one simple and homogeneous fluid, other difficulties are still behind; the flavour, though the essential part, is not however the only one; the colour, the proof and the softness must be regarded, before a spirit, that perfectly resembles French brandy can be procured. With regard to the proof, it may be easily hit, by using a spirit rectified above proof; which after being intimately mixed with the essential oil of wine, may be let down to a proper standard by fair water. The softness may in a great measure be obtained by distilling and rectifying the spirit with a gentle fire; and what is wanting of this criterion in the liquor, when first made, will be supplied by time; for it must be remembered, that it is time alone that gives this property to the French brandies; they being at first like our spirits, acrid, foul and fiery. But with regard to the colour, a particular colour is necessary to imitate it to perfection; and how that may be done is considered in the article on colouring spirits.

Our observations respecting the methods of imitating spirit, are not made with a view to favour impositions, by palming them off as real; but we are not sensible of the impropriety of selling them as imitation spirits.

We will further suggest to those, who, in order to reduce the price of spirits, mix some of the pure (the spirit which they wish to imitate) with neutral spirit, that quite an improvement can be made in imitating French brandies, by adding a small quantity of rich mountain *Malaga* wine, commonly called *sweet wine*. The experiment will convince us of the fact, though we still adhere to our first position, that

the essential oil obtained from the lees of wine to be the best; but to those who do not deal largely, this last method may be substituted advantageously. The reader is also referred to remarks on apple spirit.

*St. Croix Rum.* For imitations that which is high scented, sweet, favoured and colourless should be selected. This will work up a great quantity of neutral spirit advantageously.

*S. Croix Rum* of prime quality is a very scarce staple, and when obtained it is generally appraised very highly—particularly by most of the city dealers, who are well acquainted with its worth for the purposes before mentioned.

Neutralized molasses spirit (commonly called neutralized N. E. Rum,) undoubtedly furnishes us with the best body for imitations. We are convinced that grain spirits fail to produce good imitations, and the same objections arise against their use, in regard to rum, which we have already inferred respecting brandies—though we are confident a great improvement might be made in rendering them more insipid—and that it is a subject of great importance to the distiller.

As the molasses spirit is manufactured from the same ingredient that produces the spirit which we wish to imitate, and enter into combination, in order to give it the flavour, is obtained, and as it is the essential oil, which gives the flavour to all spirits, the difference then, in these spirits must proceed from the different processes of manufacture and also the quality of the cane must be taken into consideration, even as we have stated respecting the grape.

Enough has already been said, to convince the reader quite a different flavoured spirit must be produced, by mixing grain spirits, with that obtained from cane, than they are intended to represent, when they are blended together. The best neutralized molasses spirit, can be obtained for ten cents per gallon more than that which is usually put up for the trade. It need not be said that the Boston market furnishes the best new rum, and that it produces also the best neutralized, of any which we have ever seen. It can easily be obtained at 60 per cent. above proof; there are considerable quantities manufactured of a very ordinary quality; consequently much care is required in selecting it. The purchaser will do well to observe, that the best is colourless, and free from a burnt or smoky flavour, which in either case, renders the spirit unfit to mix.

For a barrel of imitation, from one to ten gallons of the pure, spirits mixed with the neutralized; and of the latter quantity, but few palates can detect, provided the goods are of the best quality.

When neutralized rum cannot easily be obtained, neutralized whiskey (or pure spirits) are substituted.

The lye of walnut, (or hickory) ashes is insipid, and has the singular property of neutralizing spirits. Spirits rendered tasteless by this process are not in the least injured, but rather acquire a degree of strength.

Could a discovery be made to deprive spirits of their intoxicating power, how much of the worlds wretchedness would be alleviated!

It is without doubt to be considered as the most wise experiment which can be made to abstain entirely from using ardent spirits unless for medicinal purposes. Who has not seen, by its too frequent use, the noblest structure, body, mind and all, swept by their enticing channels over a fathomless cataract? Who can be so insensible to the calls of humanity, amidst the scenes of misery which an inordinate love of ardent spirit produces, that will not come to the determination accompanied with a rigid adherence, to aid in paving the way of reform?

*St. Vincents* is next in quality to *St. Croix*, and admits of the same process as described above, in order to reduce the price. However, it must always, be considered that much depends on the quality of the goods which you blend with the neutralized spirit; much care and experience is required to select that which is high scented and fine flavoured: the difference of cargoes in this respect, is more than we are generally inclined to admit.

*Grenada Rum*, can be imitated very well, with the neutralized molasses spirit, and a small quantity of very high flavoured *Jamaica* spirits.

*Jamaica Spirits*, if highly scented, are very much improved by adding the neutralized molasses spirit; the compound would be preferred by most palates, after acquiring a sufficient ripeness.

Neutralized molasses spirit of the first quality will pass for better inward Island rum, than any rum of the Islands can, with the least addition of grain spirit.

*Holland Gin*, can be reduced in price, and a very fair fla-

vour retained, by mixing it with that which is manufactured in our country : some of the American is very nearly as good as imported ; and would be quite, if the manufacturers were as careful as the Hollanders in manufacturing it : age, however, is a very necessary qualification to recommend all spirits.

*Neutralized Whiskey* mixes with gin better than any other spirit ; and if it must be resorted to, in order to reduce the price of the Holland gin, we would recommend a very small quantity of the oil of juniper, to be added, (first mixed with high wines, and then added to a small quantity of gin, when the whole may be put into the cask,) though we should prefer a few fresh juniper berries, when they can be easily obtained : mash them and digest in alcohol a short while, then pour the tincture into the cask.

We have been informed that large butts have been contrived so as to contain two or three others, for the purpose of holding different qualities of spirits, but in such a manner as to appear to be drawn from only one cask. We may therefore infer, that such casks are sometimes intended for deception, and that it is probable the samples will not always correspond with such as are delivered. From this développement, we may learn that however "sharp" the retailer may be, respecting the quality and prices of the goods which he purchases, it is no less for his interest, that he also, becomes fully satisfied at the time of delivery with that which he would naturally anticipate, when rolled into his own warehouse.

It was an old adage, that spirits and wines, on arriving at their place of destination, "had crossed many rivers and brooks," particularly when transported into the country.

Some have even thought that spirits would not bear reducing so much, with soft or country, as with the city water—which they were inclined to believe had some peculiar qualifications, which country water did not possess.

There is another singular operation which we will allude to, though it would seem, that it must be managed with great address. It is said that samples of spirits exhibited in proof glasses, appear to much better advantage in cold weather, after having held them sometime in the hand—as the caloric or heat leaves the hand, it is imparted to the fluid, producing a more lively action—(see also remarks on the expansion of liquids in the chapter on caloric.)

We should suppose the winter season the most favourable for operations of this kind, as the fire is as wonderful attractor for the hands.

*The Arcometer* is in general use, which is made of glass with a round hollow body ending in a long slender neck, sealed hermatically at the top, into which there is first put as much quicksilver as is sufficient to keep it swimming in an exact position; its neck being divided into degrees the quality and lightness of the liquor is judged of by the depth of the vessel's sinking.

## CHAPTER XXXI

*To make Spirits of Wine—Sugar Spirits—Cherry Brandy—Apple and Raisin Spirits—Cordials—Wines—Metheglin—Mead—Ratafias—Creams—Shrubs—Beers—Porter Noyeaux—Artificial Waters.*

*To make Spirits of Wine.* It is in England generally obtained from ground meal, either of wheat, rye or barley, with from one-tenth to one-third of the same, or other grain, malted and ground and then called malt spirits; or from treacle, and then called molasses spirits; some is made from apples, or cider wash. The fermentation is carried on quicker and farther, than in brewing, or making cider in order that all the sugar in the wash may be converted into spirit and water. The infusion of the malt and meal is made so strong, that its specific gravity is reduced from 1.083 to 1.14, whereas that for strong ale, is generally 1.06, and for small beer, 1.015 to 1.04, and is mixed with a large quantity of yeast, added by successive portions, until in about ten days, the specific gravity is reduced to 1.002, when it is fit for the still. In general, a third part is drawn off at the first stilling, under the name of low wines, the specific gravity being about 0.975.

On re-distilling the low wines, a fiery spirit, of a milky cast, comes over first, and is returned into the still; then follows the clear spirit; when it begins to grow too watery, the remaining spirit that comes over, as long as it will take fire, is kept apart, under the name of faints, and mixed with the next parcel of low wines. Instead of these trials, the head of the still may have a bulb of a thermometer inserted into it, and by observing the temperature of the steam, an accurate judgment may be formed of the strength of the spirit that distils over.

It is computed that one hundred gallons of malt, or corn

wash, will produce about twenty of spirit, containing about half its weight of water; molasses wash twenty-two gallons, cider wash fifteen gallons. The best French wines yield from twenty to twenty-five gallons. The spirit thus obtained is used for pharmaceutical purposes, mixed with water, to separate the oil it contains, and re-distilled several times in tall vessels, with a very gentle heat until its specific gravity is reduced to 0.82; though that usually sold is only 0.837, at 60° Fahrenheit. By distilling spirits of wine with purified pearlashes, salts of tartar, muriate of lime, or common salt, all previously heated to redness, and cooled, its specific gravity may be reduced still lower, even as low as 0.792, at 68° Fah. but there is reason to think that it not only parts with water, but undergoes some change, or acquires some impregnation, by these additions, as its taste is altered. The spirits of wine from which every particle of water is separated, is called by the Arabic name of alcohol.

*Sugar Spirits.* It is meant by sugar spirits, that extracted from the washings, scumming, dross and waste of a sugar baker's house. These recrementitions or drossy parts of the sugar are to be diluted with water, in the same manner as molasses or wash, and then distilled in the common method; and if the operation be carefully performed, and the spirits well rectified, it may be mixed with foreign brandies and even arrack in a large proportion, to great advantage; for these spirits will be found superior to that extracted from treacle, and consequently more proper for these uses.

*Cherry Brandy.* This liquor is greatly called for in the country, and is made in different ways. Some press out the juice of the cherries, and having dulcified it with sugar and water, add as much spirits to it as the goods will bear, or the price it is intended to be sold for. But the common method is to put the cherries clean picked into a cask, with a proper quantity of proof spirits, and after standing eighteen or twenty days, the goods are drawn off into another cask for sale and about two-thirds of the first quantity of spirit poured into the cask upon the cherries. This is suffered to stand about a month to extract the whole virtue from the cherries, after which it is drawn off as before; and the cherries, pressed to take out the spirits they had absorbed. The proportion of cherries is not very nicely observed: the general rule is to let the cask be about half filled with cherries and then filled up with proof spirits.

Some add to every twenty gallons of spirits, half an ounce of cinnamon, an ounce of cloves, and about three pounds of sugar; by which the flavour of the goods is considerably increased. But in order to save expense, not only the spices and the sugar are omitted, but also a great part of the cherries, and the deficiency supplied by the juice of elder berries, sometimes adding molasses to sweeten instead of sugar, when the elder berries are not made use of.

*Raisin and Apple Spirits, &c.* By raisin spirits are to be understood that extracted from raisins after a proper fermentation. In order to extract the spirits, the raisins must be infused in a proper quantity of water and fermented in the manner described in the article on fermentation. When the fermentation is completed, the whole is to be thrown into the still, and the spirits extracted by a strong fire. The reason why a strong fire is directed, is because by that means a greater quantity of the essential oil will come over the helm with the spirits, which will render it much fitter for the distiller's purpose; for these spirits are generally used to mix with common malt goods: and it is surprising how far it will go in this respect; ten gallons of it being sufficient to give a determining flavour and agreeable vinosity to a whole piece of malt spirits. It is therefore well worth the distiller's attention to endeavour at improving the common method of extracting spirits from raisins; and perhaps the following hint merits attention. When the fermentation is completed and the still charged with fermented liquor as before directed, let the whole be drawn off with as brisk a fire as possible; but instead of the cask or can, generally used by our American distillers for a receiver, let a large glass, called by chemists, a separating glass, be placed under the nose of the worm, and a common receiver applied to the spout of the separating glass; by this means the essential oil will swim upon the top of the spirits, or rather low wine, in the separating glass, and may easily be preserved at the end of the operation. The use of this limpid is well known to distillers, who have made their business a scientific study; for in this resides the whole flavour, and consequently may be used to the greatest advantage in giving that distinguishing taste and true vinosity to the common malt spirits. After the oil is separated from the low wine, the liquor may be rectified in *balneum mariæ*, into pure and almost tasteless spirits, and therefore

well adapted to make the finest compound cordials, or to imitate or mix with the finest French brandies, arracks, &c. In the same manner, spirits may be obtained from cider. But as its pasticular flavour is not so desirable as that obtained from raisins, it should be distilled in a more gentle way, and carefully rectified in the manner shown in the article on rectification, by which means, very pure and almost tasteless and insipid spirits will be obtained which may be used to very great advantage in imitating the best brandies of France, or in making the finest compound waters or cordials.

*Anise Seed Cordial.* Take of anise seed bruised two pounds, proof spirit twelve and a half gallons, water one gallon; draw off ten gallons with a moderate heat.

This water should never be reduced below proof, because the large quantity of oil with which it is impregnated, will render the goods milky and foul, when brought down below proof. But if there is a necessity for this, their transparency may be restored by filtration.

*Peppermint Cordial.* Oil of Peppermint seventy-five drops, sugar one ounce, grind together; add spirits of wine rectified one pint; dilute with spirits of wine rectified ten pints, water ten gallons, and fine with alum three drachms. On a similar principle, most cordials can be made, though with a little variation in the formula in some cases. Taste and the habits of the place are to be consulted. In general, it is advisable to filter.

In dulcifying or sweetening spirits, weigh the sugar, and dissolve it in one or more cans of the water, with which the compound is to be made up; bruise the sugar, and stir it well, till all is dissolved; then empty it into the cask containing the spirits; mixing all together, by drawing off several cans by the cock, and emptying them into the cask by the bung hole. Now rummage all well together, till they are perfectly compounded. Spirits or compounds that are strong, require no assistance in settling and becoming clear, but those that are weak, must be refined by the addition of some other substance. To every hogshead of Geneva or other spirituous compound, put six ounces powdered alum, previously dissolved in three or four gallons of the compounds, and stir all well together. In the course of twenty-four hours, the whole will be rendered completely clear. It is a good practice to leave the bung holes of the casks (containing spirits or compounds newly



made,) open for several days; this improves their flavour, and renders them clear, sooner than they otherwise would be.

Table salt thrown into the still, in the proportion of six ounces to ten gallons of any liquid to be distilled, will greatly improve the flavour, taste and strength of the spirit. The viscid matter will be fixed by the salt, whilst the volatile matter ascends in a state of great purity. The flavour of malt spirits is highly improved by putting three and a half ounces finely powdered charcoal, and four and a half ounces ground rice, into a quart of spirits, and letting it stand fifteen days, frequently stirring it; then let the liquor be strained, and it will be found nearly of the same flavour as brandy.

*Clove Cordial.* Cloves, bruised, four pounds, pimento half a pound, proof spirit sixteen gallons.

Digest the mixture twelve hours in a gentle heat, and then draw off fifteen gallons with a pretty brisk fire. The water may be coloured red with tincture of cochineal, or other colouring matter.

*Raisin Wine.* Raisins one hundred weight, water sixteen gallons, soak for a fortnight, stirring every day; press, put the liquor in a cask with the bung loose, till it has done hissing; then add four pounds of brandy and bung up close. Some use little more than half, or two-thirds of this quantity of raisins.

*Gooseberry Wine.* Ripe berries, bruised, ten gallons, water thirty gallons, soak twenty-four hours, strain: to each gallon add two pounds of sugar and ferment.

2. Bruised berries eighty pounds, water ten gallons, soak for a day, strain; to each gallon add six pounds of loaf sugar, and ferment.

3. Juice ten gallons, water twenty gallons, sugar seventy pounds, ferment.

4. Berries one hundred pounds, brown sugar six pounds water a sufficient quantity to fill a fifteen gallon cask; yields a good yellowish white, and very transparent wine.

5. Gooseberries forty pounds, water four gallons, bruise together; the next day press out the juice: to every gallon add three pounds of sugar; ferment.

*Currant Wine.* Red currants seventy pounds, bruised and pressed, brown sugar ten pounds, water a sufficient quantity to fill up a fifteen gallon cask; yields a pleasant red wine, rather tart, but keeping well.

2. White currants one sieve, red currants one gallon; press. To each gallon of juice, add three gallons of water; to ten gallons of liquor add thirty pounds of sugar and ferment; when you bung it up, add two pounds of brandy to each ten gallons of wine.

3. Juice eleven quarts, that is, the produce of one sieve, sugar twenty pounds, water a sufficient quantity to fill up a nine gallon case; ferment—and when it has done working, add four pounds of brandy; for a half hogshead use three sieves of currants, sugar three-fourths of a hundred weight, brandy one gallon.

*Black Currant Wine.* Berries twenty pounds, brandy two to four pounds, water twelve to fourteen gallons, yeast, two spoonfuls, fermented for eight days, then bottled and well corked; yields a pleasant, rather vinous, cooling liquor of a purple colour; or they may be made into wine like the common currants; by the first process the wine is dark purple, rather thick, but good.

*English Sherry.* Loaf Sugar thirty- two pounds, sugar candy ten pounds, water sixteen gallons, boil; add pale ale wort, (as for English Madeira,) six gallons, yeast, one pound; on the third day add ten pounds of stoned raisins, and in another two or three days one gallon of brandy; bung it down for four months; drawn it off into another cask, add one gallon of brandy, and in three months bottle it.—imitations for foreign wines, for those who wish to make a show above their circumstances, but far inferior to our own fruit wines.

*Elder Wine.* Juice of the berries eight gallons, water twelve gallons, brown sugar sixty pounds, dissolve by boiling, add yeast, and ferment; then add four pounds of brandy, and bung it up for three months: disagreeable when cold, but is mulled with allspice and drank wram in winter time as a stimulant.

*Ginger Wine.* Bruised ginger twelve pounds, water ten gallons; boil for half-an hour, add twenty-eight pound of sugar, boil till dissolved, then cool, and put the liquor along with fourteen lemons sliced, and three pounds of brandy; add a little yeast and ferment.

*White Spruce Beer.* To ten gallons of water, put six pounds of sugar, four ounces essence of spruce, add yeast, work as in making beer, and bottle immediately in half pints.

*Mixed Fruit Wine.* White currants three sieves, red

gooseberries two sieves: these should yield forty pints of juice; to each gallon add two gallons of water, sugar three pounds and a half; ferment.

2. White, red, and black currants, cherries, especially black heart, raspberries, of each, pounded, equal quantities. To each four pounds of the bruised fruit add one gallon of water, steep for three days, press, and to each gallon of liquor add three pounds of yellow sugar; ferment, and when finished add to each nine gallons two pints of brandy; if it does not find soon enough, add half an ounce of isinglass, dissolved in a pint of water, to each nine gallons.

*Cherry Wine.* Cherries thirty pounds, moist sugar five pounds, water a sufficient quantity to fill a seven gallon cask; ferment.

*Parsnip Wine,* may be made by cutting the roots into small, thin slices, boiling them in water, pressing out the liquor, and fermenting it. This wine, when made strong, is of a rich and excellent quality and flavour.

*Orange Wine.* Sugar twenty three pounds water ten gallons. boil; clarify with the white of six eggs. pour the boiling liquor upon the parings of one hundred oranges and the strained juice of these oranges, and six ounces of yeast; let it work for three or four days then strain it into a barrel, bung it up loosely; in a month add four pounds of brandy; and in three months it will be fit to drink.

*Wines,* may also be made of blackberries and other English fruits upon the same principle. Those mentioned are the methods generally employed, but most persons have peculiar ways of proceeding, which may indeed be varied to infinity, and so as to produce at pleasure a sweet or dry wine; the sweet not being so thoroughly fermented as the dry. The addition of brandy destroys the proper flavour of the wine, and it is better to omit it entirely (except for elder and port wine, whose flavour is so strong that it cannot well be injured) and to increase the strength by augmenting the raisin or sugar. In general the must for wines ought to be made of six pounds of raisins, or four pounds of sugar, to the gallon, allowing for that contained in the fruit.

*Southampton Port.* Cider thirty six gallons, elder wine eleven gallons, brandy five gallons, damson wine eleven gallons, M.

*English Madeira.* Pale malt ground, four bushels, boiling

water forty-four gallons, infuse, strain; of this wort, while warm, take twenty-four gallons, sugar candy fourteen pounds; when dissolved, add two pounds of yeast; ferment; keep skimming off the yeast; when the fermentation is nearly finished, add two gallons and a half of raisin wine, brandy, port wine, of each two gallons; bung it down for six or nine months. A second infusion of wort may be brewed for beer.

*Sweet Wine.* Sweet cider after fermentation, if not sufficient luscious, add molasses, s. q. a few pounds malaga raisins, mashed and digested in some of the Cider, and a little liquorice root to give it a flavour; then, reduce with soft water until it suits the palate. It may be necessary to put in a little isinglass to render it clear. This method of imitation, if managed with care produces an excellent drink, equal if not superior to that which is imported.

*English Champaign.* Raw sugar ten pounds, loaf sugar twelve pounds, water nine gallons, concrete acid of lemon, or crystallized acid of tartar six drachms; dissolve by a gentle boil; before it grows cold add about one pound of yeast, and ferment. When the working is nearly over, add perry one gallon, brandy three pounds, and bung it up for three months; then draw out two pounds of the wine, dissolve one ounce of isinglass in it, pour it again into the cask, and in a fortnight bottle it; it may be coloured pink by adding one ounce of cochineal when first bunged up.

*English Port.* Cider twenty-four gallons, juice of elder berries six gallons, port wine four gallons, brandy one gallon and a half, logwood one pound, isinglass twelve ounces, dissolved in a gallon of the cider; bung it down; in two months it will be fit to bottle, but should not be drank till the next year. If a rough flavour is required, four to six ounces of alum may be added.

*To restore Wine fusted or tasting of the cask.* Draw the wine entirely out of its own lee and put it in another cask over a good lee. Then through the bung hole, hang up a bag with four ounces of laurel berries in powder and a sufficient quantity of steel filings at the bottom of the bag, to prevent its swimming on the top of the wine; and in proportion as you draw a certain quantity of the liquor, let down the bag.

*To prevent Wine from Pricking.* Put in the cask half a pound spirits of tartar, or when the wine is new, throw in two ounces of common alum for every hogshead.

*To clarify Wine easily.* Put in the cask one pound of fine shot.

*To correct a musty taste in Wine.* Knead a dough of the best wheat flour, and make it in the form of a rolling pin, or a short thick stick: Half bake it in the oven and stick it all over with cloves; replace it in the oven and bake it quite. Suspend it in the cask over the wine without touching it, and let it remain there, or else plunge it in the wine.

*To correct a bitter or sour taste in Wine.* Boil a quart of barley in four quarts of water to the reduction of two. Strain what remains through a cloth, and pour it in the cask; stirring all together with a stick without touching the lee.

*To restore spoiled Wine.* Change the wine from its own lee upon that of good wine. Pulverize three or four nutmegs and as many dry orange peels; and throw them in; stop well the bung, and let it ferment one fortnight. After that term is over you will find it better than ever. This method has gone through many experiments.

*To prevent tartness in Wine.* Take in the month of March two basins full of river sand, and after having dried it in the sun or in the oven throw it in the cask.

*Metheglin.* Honey one hundred pounds, boiling water a sufficient quantity to fill a half hogshead or thirty-two gallon cask, stir it well for a day or two; add yeast, and ferment. Some boil the honey in the water for an hour or two; but this hinders its due fermentation.

*Mead,* is made from the honey-combs from which honey has been drained out, by boiling in water, and then fermenting, generally confounded with metheglin.

*Ratafia des Cerisis.* Morello cherries with their kernels bruised, eight pounds, proof spirits eight pints; digest for a month; strain with expression; add sugar one pound eight ounce.

*Ratafia de Grenoble.* Small wild black cherries with their kernels bruised, twelve pounds, proof spirits six gallons; digest for a month; strain; add sugar twelve pounds; a little citron peel may be added at pleasure.

*Ratafia de Noyeaux.* Peach or apricot kernels, with their shells bruised, in number 120, proof spirits four pints, sugar ten ounces. Some reduce spirits of wine rectified to proof, with the juice of apricots or peaches to make this liquor.

*Chreme de Noyeau—English.* Bitter almonds blanched four ounces, proof spirits two pints, sugar one pound.

*Chreme de Orange—English.* Oranges sliced in number thirty-six, spirits of wine rectified, two gallons, sugar eighteen pounds, water four gallons four pints, tincture of saffron one ounce four drachms, orange flower water four pints; digest for a fortnight; strain.

All the aforementioned liquors are stimulent and taken *ad libitum* for pleasure.

*Chreme des Barbadoes.* Orange peels, lemon peels, of each three in number, cinnamon four ounces, mace two drachms, cloves one drachm, rum eighteen pints; distil in balneum mariæ, and add sugar p. æq.

*Chreme des Barbadoes—English.* Lemons sliced in number twenty-four, citrons sliced, in number six, spirits wine rectified two gallons four pints, fresh balm leaves eight ounces, water three gallons four pints; digest for a fortnight; strain.

*Brandy Shrub.* Brandy nine pints, lemon juice, orange juice, of each one pint, orange peels four in number, lemon peels two in number, sugar two pounds, water five pints.

The same formula will answer for making rum shrud, using rum instead of brandy.

*Rum Shrub.* Concrete acid of lemons eight ounces, water five gallons, raisin wine four gallons, rum ten gallons, orange flower water four pints, honey six pounds.

*Brown Spruce Beer,* as the white, using molasses in lieu of the sugar. In regard to the white and brown spruce and ginger beer and the wines, it is said the purer kinds are mixtures of spirits of wine, water, and extractive matter: the spirits may be separated by careful distillation, or if the extractive matter be first got rid of by the addition of extractum saturni and filtration, the spirits may be separated by adding very pure kali ppm. when it will swim upon the liquor; the spirit constitutes from twelve to twenty-five per cent. of the proper wines, and from two to eight per cent. of the malt liquors.

The fermentation of these liquors is usually hastened by the addition of yeast, crude tartar, or bruised vine leaves, but this is seldom necessary for wines, if the liquor be kept in a proper warmth; but malt liquors are more sluggish.

If the fermentation is in danger of proceeding too far, it may be stopped by drawing off the liquor clear into another vessel in which some brimstone has been newly burned, or in

the case of red wine, some nutmeg powder upon a hot shovel, or which has been washed with brandy; the sediment left in the old cask, may be strained through flannel or paper, and clear and added to the other; instead of this a part of the wine may be drawn out of the cask and some rags dipped in a little brimstone and lighted, may be held by a pair of tongs over the bung hole slightly covered, so as to impregnate the liquor with the fumes; about one ounce of brimstone to a hogshead, then returning what had been drawn out, and bunging it very close; or a small quantity of oil of vitriol may be added in: lastly the addition of black manganese has been proposed on theoretical grounds.

If the fermentation has proceeded too far, and the liquor sours, the fermentation must be stopped as above, and some lumps of chalk, or burned oyster shells added, to saturate the acid already generated.

If the liquors do not become clear soon enough, for each thirty gallons dissolve one ounce of isinglass in two pounds of water. Strain, and mix this with part of the liquor, and stir it up to a froth, and pour it into the liquor. Stir the whole well and bung it up: instead of isinglass some use hachish or shavings in rather larger quantities. Red wines are fined with twelve eggs to the pipe; beaten up to a froth, and well stirred and mixed in with the wine.

If the liquor has acquired a bad flavour, the best way is to let the fermentation go on, and convert it at once into vinegar.

*To make treacle Beer.* Boil two quarts of water into one pound of treacle, stir them together till they are well mixed; then put six or eight quarts of cold water to it and about a tea cup full of yeast or balm; put it in a clean cask or tub; cover it over with a coarse cloth two or three times double; it will be fit to drink in two or three days. The second or third time of making, the bottom of the first beer will do instead of yeast; if you make a large quantity, or intend it for keeping; you must put in a handful of hops and another of malt for it to feed on; and when done, stop it up close.

The above is the best and cheapest way of making treacle beer, though some people add raisins, bran, woad, and spices, such fruit, &c. as are in season; but that is just as you fancy. Indeed, many pleasant, cheap, and whetstone

drinks may be made from fruits, &c. if they are bruised and boiled in water before the treacle is added.

*London Porter.* For five barrels: malt eight bushels, a sufficient quantity of water, mash at twice; add in the boiling, hops eight to twelve pounds, treacle six pounds, liquorice root eight pounds, moist sugar sixteen pounds, one half of which is usually made into essential binæ and the other half into colour, capsicum four drachms, Spanish liquorice two ounces, linseed one ounce, cinnamon two drachms, heading two drachms; cool, add one to two gallons of yeast when it has got a good head, cleanse it with three ounces of ginger; coculus indicus one ounce; then barrel and finish the working; fine with isinglass. The public brewers use a mixture of pale amber alone, which is best for private families.

Six pounds of sugar is esteemed equal in strength, and one pound coriander seed in intoxicating power, to a bushel of malt; the sugar employed is burnt to colour the beer instead of drowm malt, and it has been proposed to use roasted coffee for the purpose. The other substances are merely to flavour the liquor and may be varied at pleasure.

The desire to evade the duty on malt in England produced the discovery of its being necessary to malt only one-third of the corn, as this proportion will convert the other into its own nature during the process.

*Artificial Spa Water.* Prepared natron seven grains, magnesia alb. one scruple, iron filings three grains, common salt one grain, water three pounds, and impregnate it with gas from marble powder and oil of vitriol, of each ten scruples, sufficiently diluted with water.

*Artificial Pyrmont Water.* Epsom salts fifteen grains, common salt five grains, magnesia alb. three grains, iron filings five grains, water three pounds, and impregnate it with the gas from marble powder and oil of vitriol, of each seven drachms.

*Artificial Sheltz Water.* Common salt one drachm, magnesia alb. one scruple, natron ppm. fifteen grains, chalk seven grains, water three pounds, and impregnate with the gas from marble powder and oil of vitriol of each six drachms.

*Of Cherry tree Bark.* The bark of black cherry tree, has been used instead of black cherries in the manufacture of cherry brandy, steeped in water with elder berries; sweetened with molasses, adding a proper quantity of rum but on account



of the following communication through a very respectable source, we shall omit giving a particular formula.

A medical gentleman says the bark of this tree is poisonous. He relates the case of a young lady, to whom he was lately called, and who in consequence of drinking about half a pint of cider, taken from a closely stopped bottle, filled the evening previous with cherry bark fresh from the tree, was seized with vertigo, stupor, and syncope, followed by great difficulty of respiration and vomiting. Similar effects were produced in a slighter degree upon another person, who took from the same bottle a small draught of cider.

The French chemists have recently ascertained that the deleterious principles by the peach is analagous to *prussic acid*.

This acid in its concentrated state, if a feather be dipped into it and drawn across the eye of an animal produces instant death. Two drops, have been known to kill a vigorous dog in a very few minutes.

*Of Adulterated Wines.* The Wines of Commerce in their purity, cannot be found at the corners of every street. Some are in the practice of mixing colmenar with Sicily Madeira—this compound makes a very pleasant wine. If Sicily Madeira is put upon Maderira lees, it becomes greatly improved—age, however, is a requisite qualification to all wines.

We have no particular formula for compounds, nor is it necessary, since the dealer must consult the taste of his customers; nor are we able to point out a particular method whereby spurious wines can be detected as a certain test, but we would recommend dealers to obtain the certificates which should accompany the casks, which may perhaps in time lessen their risk.

We are told that empty Rum, Wine, Gin or Brandy cask, with the original certificates, are considered very valuable by the city dealers—rum hhds. with the certificates have frequently been sold at from \$10 to \$12 each. Wine qr. casks, \$4 and \$5. Brandy pipes \$12 and \$15: though there is a penalty incurred by the transaction; and we observed a notice last May, issued from the custom-house, New-York, that thereafter the law would be rigidly enforced, [See laws relative to spirits, wines, teas &c.]

## A TABLE

Presenting a comparative view of the properties of some of the most celebrated Minerals, both in America and Europe; numbered from 1 to 27 inclusive; shewing the number and quantity of articles in four Pints, or 115.5 Cubic Inches, of the Water of each Spring—the quantities in Grains and Decimal Parts of a Grain, from the latest Authorities.

NAMES OF SPRINGS.		No.	Tem- pera- ture.	Inches car- bonic acid gas.	Inches sulphur- retted hydro- gen gas
SARATOGA WATERS.	Congress,	1	50	171.089	
	Columbian,	2	50	118.	
	Washington,	3	48	123.5	
	Hamilton,	4	48	142.	
	Flat Rock,	5	48	126.25	
	High Rock,	6	48	121.36	
	President,	7	51	157.132	
	Red Spring,	8	48	75.25	
	Ellis' Spring,	9	47	112.25	
BALLSTON WATERS.	Taylor's Wash'ton,	10	48	125.5	
	Ballston Spa,	11	50	105.	
	Low's Spring,	12	52	110.	
	Sulphur,	13	52	72.	3.5
	New Spring,	14	50	159.5	
	Saratoga Sulphur,	15	50	21.75	5.5
CHELTON- HAM.	Saline Spa,	16	55	15.18	
	Chalybeate Spa,	17	53	12.	
	Montp'r Wells, 1,	18	53	8.5	
England.	. . . No. 2.	19	52	3.95	5.5
, in Germany, Pouhon Spring,		20		51.16	
—Pymont,		21		104.	
—England,		22		4.	9.5
—Wells, or, Aken Water,		23	143	some.	much.
—Well, England,		24	74	15.	
—King's Bath, England,		25	116	4.	
Bohemia—Carlsbad,		26	165	20.	
Germany—Saltzer Water,		27		70.	

NOTE. Besides those ingredients mentioned in the table, the Saline Spa contains Carbonate and muriate of magnesia 12.5 sulphate of soda and magnesia 240. Chalybeate Spa, muriate of lime 1.275. Montp'r Well, No. 1. muriate of lime 18. muriate of magnesia 49.122 muriate of magnesia 20. No.2 muriate of lime 12.06 sulphate of magnesia 24.06. muriate of magnesia 14.5 hydrogen sulphate lime 16.375 Germany Pyrmont sulphate of magnesia 22.28 Harrowgate, Eng. muriate of lime 6.5 sulphate of magnesia 5.25 muriate of magnesia 45.5 Bristol Hot Well, Eng. muriate magnesia 3.625. all of which are included in the total quantity.

No.	Muriate of Soda.	Carbonate of Soda.	Carbonate of Lime.	Carbonate of Magnesia.	Carbonate of Iron.	Sulphate of Lime.	Total quantity.
1	235.75	8.25	89.238	1.678	3.084		338.
2	100.75	11.25	60.5	0.75	3.75		117.
3	115.75	8.25	63.75	1.25	3.		192.
4	134.75	12.25	73.75	3.75	1.5		226.
5	97.4	5.6	53.5	0.75	3.75		161.
6	105.	9.	57.5	0.25	2.25		174.
7	67.5	9.5	53.75	1.25	3.		135.
8	58.76	12.24	48.5	1.5	3.		124.
9	94.	5.	55.25		3.75		158.
10	156.77	13.23	70.	2.75	2.05		249.
11	79.5	4.5	37.25	1.25	3.75		126.
12	71.	5.	32.25	0.75	3.		112.
13	32.	3.	15.		2.		52.
14	79.25	6.5	30.77	4.25	3.75		124.52
15	11.8	0.7	16.55		0.95		30.
16	2.5				2.5	20.	277.5
17	1.01				0.68	0365	9.605
18	109.87				3.575	42505	283,085
19	91.625		9.	2.875		33.25	230.25
20	.688	5.88	5.88	17.84	2.25		32.528
21	6.24		17.04	40.12	2.24	34.32	123.04
22	307.75		19.25	2.75			377.
23	20.	48.	19.				87.
24	2.		6.75			5.876	23.875
25	26.		11.25		trace.	15.75	66.
26	22.12	47.04	16.60		trace.		251.8
27	70.	16.	12.	20.			108.

## CHAPTER. XXXI

*Useful Receipts.*

*Lemon Beer.* Three pounds of lump sugar, ten ounces bruised ginger, one ounce cream tartar, lemons number four pour on them four gallons boiling water, add eight ounces of yeast, work for four days, then bottle in half pints, and tie the corks down.

2. Six pounds of moist sugar, five ounces of ginger, two ounces of cream tartar, lemons number four, eight ounces of yeast, seven gallons of water, work two or three days, strain, add one pound of brandy, bung very close, and in fourteen days bottle it; a cooling effervescent drink in summer.

*To fine Spirits.* Mix a small quantity of wheat flour in water, as if for making paste, and pour the same into the vessel. The whole is then to be well roused, and in a short time the contents will become bright.

*Cedrat.* Lemon peels in number twelve, spirits wine rectified two gallons; distil in *balneum mariæ*, and add simple syrup p. æq.

*Parfait Amour.* The same coloured with a little cochineal.

*Wine Test.* When wine becomes partly acetous, called pricked wine, the disagreeable taste is often corrected by sugar of lead; it is then poisonous, and the fraud ought to be detected. This may be done by dropping it into a little water, charged with sulphuretted hydrogen gas; it will immediately become a dark brown.

*To turn Wine into Vinegar in less than three hours.* Put in the wine a red beet, and it will be quite sour and true vinegar in less than three hours.

*To restore such Wine to its first taste.* Take off the red beet and in its stead put a cabbage root into that wine, and it will return to its primary taste in the same space of time.

*Escubæ Usquebaugh.* Saffron one ounce, juniper berries four drachms, dates without their kernels, raisins, of each three ounces, jujubs six ounces, anise seed, mace, cloves, coriander seed, of each one drachm, cinnamon two drachms, proof spirits twelve pints, simple syrup six pounds; pectoral, emmenagogue.

*Scotch Mamelade.* Juice of Seville oranges two pints, yellow honey two pounds, boil to a proper consistence.

*Essence of Spruce* is prepared by boiling the twigs of Scotch fir in water, and evaporating the decoction till it grows thick; used to flavour treacle beer instead of hops.

*Essence of Malt* is prepared by infusing malt in water, first boiled, and then cooled till it reflects the image of a person's face in it, pouring off the infusion, and evaporating it to the consistence of new honey; used in sea voyages and places where malt cannot be procured to make beer.

*Dover's Sudorific Powder.* Take of ipecacuanha in powder, opium purified, each one part, sulphate of potash eight parts, triturate them together in a fine powder.

The sulphate of potash from the grittiness of its crystals, is perhaps better fitted for tearing and dividing the tenacious opium than any other salt; this seems to be its only use in the preparation. The operator ought to be careful that the opium and ipecacuanha be equally diffused through the whole mass of powder, otherwise different portions of the powder must differ in degrees of strength.

This powder is one of the most certain sudorifics, and as such, was recommended by Dr. Dover as an effectual remedy in rheumatism. Modern practice confirms its reputation, not only in rheumatism, but also in dropsy, and several other diseases, where it is often difficult by other means, to procure copious perspiration. The dose is from two to five grains, repeated according to the patient's stomach and strength. It is proper to avoid drinking immediately after taking it, otherwise it is apt to be rejected, before any other effect can be produced. Perspiration should be kept up by diluents.

*Plummer's Pills.* These pills are diaphoretic, alterative, purgative, and beneficial in cutaneous eruptions.

Take of calomel, sulphate of antimony, of each one drachm, gum guaiacum two drachms. Mix them assiduously with mucilage, and divide into sixty pills, two pills forming the dose. To be taken at night.

*Earl Warwick's Powders.* Scammonii two ounces, antimonii daph. one ounce, crem. tart. half an ounce.

*Storey's Worm Cakes.* Calomel, jalap, of each one drachm, ginger two scruples, sacch one ounce, cinnabar anti, a sufficient quantity to make into cakes.

*Worm Cakes.* Scamm. Allep. two ounces, calomel ppd, three ounces, res. jalap two ounces, crem. tart. four ounces,

white sugar three pounds, mucil. g. trag. a sufficient quantity.

*Worm Pills.* Calomel one ounce, sugar two ounces, starch one ounce, mucil. gum trag. a sufficient quantity. to make two hundred and forty-eight pill; dose, number one night and morning, for children.

*Refined Juice or Liquorice.* Spanish liquorice four pounds, gum Ara. two pounds, water a sufficient quantity; dissolve, strain: evaporate gently to a soft extract. roll in cylinders, cut into lengths, and polish, by rubbing them in a box; expectorant in coughs, &c.

*Pate de Reglisse Noire.* Refined liquorice eight ounces, gum Arabic two pounds, sugar one pound, water a sufficient quantity; dissolve and evaporate, till it forms a very thick syrup, add rad. enulæ. camp. rad. irid. flor. of each half an ounce, ess. de cedrat a few drops, put into tin moulds, and dry in a stove.

*Young's Purging Drink.* Crystallized natron two and a half drachms, crystals of tartar three drachms, water eight ounces, corked up immediately in stone bottles and wired: a pleasant cooling laxative in summer.

*Ward's White Drops.* Quicksilver twelve ounces, spirits nitre two pounds; dissolved; add ammonia, ppa. fourteen ounces, evaporate so as to form a light salt, which drain and dissolve in rose water, three pounds and a half.

*Greek Water,* is prepared and used in the same manner for turning the hair black.

Some perhaps might give a preference to the following preparation. Quicksilver four ounces, spirits of nitre one pound; dissolve; add ammonia ppa. seven ounces: evaporate and crystallize, then dissolve each pound of salt in three pints and a half of rose water.

*Godfrey's Cordial.* Dissolve half an ounce of opium, one drachm of sassafras in two ounces spirits of wine: now mix four pounds of treacle, with one gallon of boiling water and when cold, mix both solutions. This is generally used to sooth the pains of children, &c.

*Lee's Windham Anti-Bilious Pills.* Pul. gamb. three pounds, aloes soc. two pounds, sapon. duc. one pound, sal. nitri half a pound, extra. of cow parsnip one pound, beat them into mass with a sufficient quantity of spirits of wine rectified.

*Lee's New London Pills.* Pulv. aloes soc. twelve ounces,

pulv. scammon. A. six ounces, pulv. gamb. four ounces, pulv. jalap three ounces, calomel pp. five ounces, sapon. cast. one ounce, syrup buckthorn, one ounce, muc. gum, Arabic seven ounces. m. ft. mass s. a. when incorporated, divide two drachms of the mass, into twenty-four pills.

*Smith's British Lavender.* Ol. lavend. Ang. two ounces, essence ambergr. one ounce, eau de luce one pint, spirits wine rect. two pints.

*Essence of Peppermint.* Spirits wine rectified one pint, put into it kali pp. one ounce, previously heated, decant, and add ol. minth. pip. half, an ounce, mix.

2. Ol. minth. pip. one pound, spirits of wine rectified two gallons, colour with herb minth. pip. sic. eight ounces, mix.

3. Ol. minth. pip. three ounces, sp. wine rect. coloured with spinage two pints; mix.

*Hill's Balsam of Honey.* Bals. Tolu one pound honey one pound, sp. wine rect. one gallon.

2. Balsam Tolu opt. two ounces, gum styra<sup>x</sup> two drachms opii pur. half a drachm, mell. opt. eight ounces, sp. wine rect. two pints, pectoral used in coughs and colds.

*Ford's Balsam of Hoarhound.* Hoarhound, liquorice root, of each three pounds eight ounces, water a sufficient quantity to strain six pints, infuse; to the infusion add proof spirits or brandy twelve pints, camphor one ounce and two drachms opium pur., Benjamin of each one ounce, dried squills two ounces, oil of anise seed one ounce, honey three pounds and eight ounces.

*Stoughton's Elixer.* Rad. gentian two pounds four ounces, rad. serp. verg. one pound, cort. aurant. sic. one pound and eight ounces, cal. aromat. four ounces, sp. wine rect. water, of each six gallons.

2. Rad. gentian four pounds, cort. aurant. two pounds, pis. aurant. one pound, cocin. two drachms, sem. cardam. min. one ounce, sp. wine rect. eight gallons.

*Hooper's Pills.* Vitriol. virid. aquæ of each eight ounces; dissolve: add aloes Barb. two pounds eight ounces, canellæ alb. six ounces, gum. myrrhæ two ounces, soponacis four drachms.

2. Sal. martis two ounces pulv. aloes c. canellæ one pound mucilage gum tragacanthæ, tinct. aloes, of each a sufficient quantity, cut each drachm into eighteen pills, put forty in a box.

*Matthew's Pills—Starkey's Pills.* Rad. helleb. nigri. rad. helleb. albi. rad. glycyrrh. opii of each two ounces, sapon. Starcken six ounces, ol. terebinth. a sufficient quantity.

2. Rad. helleb. nigri. rad. glycyrrh. sapon. castill. rad. circumæ, opii puriff. syr. croci. of each four ounces, ol. terebinth. a sufficient quantity.

*Barclay's Anti-Billious Pills.* Extract colocynth. two drachms, resin. jalap one drachm, sapon. amygdal. one drachm and a half, guaiaci three drachms, tart. emet. eight grains, ol. junip. ol. carui, ol. rorismar. of each four gtt. syr. spin. cerv. a s. q. make into sixty-four pills.

*Worm pills.* Calomel one ounce, sugar two ounces, starch one ounce, mucil. gum traga. a s. q. to make two hundred and forty-eight pills; dose, number one, night and morning for children.

*Keyser's Pills.* Hydrag. acetat four ounces, manna thirty ounces, starch two ounces, mucil. gum traga. s. q. make into pills of six grains each; dose, number two, nocte maneqe, increasing the dose to number twenty-five, or more; a box of 1000 or 1200 is usually sufficient.

*Dalby's Carminative.* Tinct. opii four and a half drachms tinct. assa. two and a half drachms, ol. carui three scruples, ol. minth. pip. six scruples, tinct. castor. six and a half drachms, sp. of wine rect. six drachms, put two drachms into each bottle with magnesia one drachm, and fill up simple syrup and a little sp. of wine rect.

*Botany Bay Cement.* Yellow gum and brick dust of each p. aeq. used to cement china ware.

*Admirable wash for the Hair to thicken its growth.* Take two ounces each of rosemary, maiden hair, southernwood, myrtle berries and hazle bark, and burn them to ashes on a clean hearth, or in an oven; with these ashes make a strong lye, with which wash the hair at the roots every day, and keep it cut short. This lixivium, it is said will destroy that unsuspected enemy to the hair, the worm at the root.

*Easy and effectual method of rendering all kinds of Paper fire proof.* This surprising effect is produced by a simple cause. It is only necessary that the paper, whether plain, coloured, written printed or stained, should be immersed in a strong solution of alum water, and afterwards thoroughly dried, when it will immediately become fire proof. The experiment may easily be made, by holding a piece of paper



thus prepared over the flame of a candle. Some paper, however, will require to imbibe more of the solution than it can do by a single immersion, in which case the dipping and drying must be repeated till the paper becomes fully saturated. It is asserted that neither the colour nor quality of the paper will receive the least injury from this operation, but that on the contrary they will be improved.

*An excellent Paste for stopping Holes or Cracks in Iron Culinary Utensils, so as to render them perfectly tight.* To six quarts of potter's clay, add one part steel filings, and of linseed oil a sufficient quantity to render the mixture of glazier's putty and fill the holes with it. This will soon become hard, and resist the action both of water and fire.

*Eau de Husson.* Is probably a mixed tincture or wine of henbane and colchicum. A tincture of colchicum has been proposed for it by Want; a tincture of hedge hyssop is said to be sold for it by Reece; and a wine of white belleb. proposed by Moore, but neither of them is possessed of the same characteristics as the Parisian medicine.

*Bateman's Pectoral Drops.* Sem. fœnic. dulc. two pounds and eight ounces, sem. anise one pound, proof spirits four gallons, water a sufficient quantity, distil ten gallons, water a sufficient quantity, distil ten gallons, to which add opium seven ounces and four drachms, camphor six ounces, kali pp. one ounce, coral rubr. four ounces.

2. Castor N. A. two ounces, opium, anisi, of each one ounce and four drachms, camph. eight ounces, sem. fœp. dulc. two ounces, tinct. antim. four ounces, proof spirits ten pints add rad. valerian and cochineal in powder.

3. Castor, camphor, of each four ounces, coccin. one ounce, spirits of wine rectified, two gallons, water one gallon.

4. Opii camph. of each one pound, castor, ol. anisi, santal. rubr. of each four ounces, treacle ten pounds spirits of wine rectified five gallons, water four gallons.

5. Opii camph. of each ten drachms, coccin. one drachm, kali ppt. four scruples, ol. fœnic. dulc. one drachm, (or seeds three ounces,) proof spirits fourteen pints, water two pints: produce fifteen pints.

6. Castor one ounce, ol. anisi one drachm, camph. five drachms, coccin. one drachm and a half, opii six drachms, proof spirits one gallon.

*Daffy's Elixir. Elixir Salutis.* Fol. sennæ four ounces, ras. lign. sant. rad. enulæ sicc. sem. anisi; sem. carui, sem. coriand. rad. glycyrrh. of each two ounces; raisins stoned eight ounces, proof spirits six pounds: This is now sold by the name of Dicey's Daffy.

2. *Tincture Sennæ. Tinct. Sennæ, P. L.* Fol. sennæ one pound, sem. card. min. half an ounce, raisins sixteen ounces; proof spirits one gallon,

3. *T. Sennæ, P. D.* The same but omitting the raisins.

4. *Sennæ Compōsita.* Fol. sennæ two ounces, rad. jalap one ounce, sem. coriand. half an ounce; proof spirits three pounds and a half by weight; when made; add white sugar four ounces.

5. Fol. sennæ, rad. rhei; sem. arisi; of each two pounds, rad. jalap, sem. carui; of each one pound; sant. rub. eight ounces; proof spirits ten gallons, brown sugar four pounds.

6. Rhubarb; East India; forty pounds; sennæ fifteen pounds, sant. subr. five pounds, sem. carui, sem. anisi, sem. coriand. of each five pounds, cineres Russici eight ounces, spirits of wine rectified ten gallons; digest three days, then add proof spirits eighty gallons; treacle forty-six pounds.

7. Rad. rhei fourteen pounds; sem. anis ten pounds; sennæ parvæ eight pounds, rad. jalap four pounds, sant. rubr. three pounds eight ounces, ciner. Russ. two pounds; spirits of wine rectified thirty-eight gallons, water eighteen gallons:

8. *Swinton's Daffy.* Rad. jalap three pounds, fol. sennæ twelve ounces, sem. coriand. sem. anisi; rad. glycyrrh. rad. enulæ; of each four ounces; spirits of wine rectified, water, of each one gallon.

9. Rad. enulæ, ras. guaiaci, sem. coriand. rad. rhei, rad. glycyrrh. sem. anisi. of each three ounces; raisins one pound eight ounces, proof spirits ten pints.

10. Rad. jalap three pounds, fol. sennæ one pound, sem. anisi six ounces, sem. coriand. four ounces, cort. aurant sicc. two ounces, proof spirits two gallons.

11. Fol. sennæ seven pounds, rad. jalap five pounds sem. anisi fourteen pounds, sem. carui four pounds, sem. scenic. dule. four pounds, brandy coloured two gallons, spirits of wine rectified twenty-six gallons, water twenty-four gallons; let it stand three weeks, strain washing out the last portions with water two gallons, then add treacle twenty-eight pounds. A common remedy in flatulent cholic, and used as a purge by

those accustomed to spirit drinking; dose one, two or three table spoonfuls.

*Anti-Attrition.* Hog's lard ten pounds, camph. four ounces, black lead a sufficient quantity to colour it; used to rub on iron to prevent rust, and diminish friction.

*Issue Peas.* Ceræ fl. one pound, rad. circum. eight ounces, rad. irid. flor. four ounces. tereb. Venit. a sufficient quantity; make into peas.

2. Ceræ flav. six ounces, rad. irid. flor. two ounces, vermillion four ounces, tereb. Ven. a sufficient quantity, form into peas.

3. Ceræ fl. six ounces, ærug. æris. rad. helleb. albi, of each two ounces, cantharidum one ounce, rad. irid. flor. one ounce and a half, tereb. Ven. a sufficient quantity; this last is caustic and will open issues of itself, the others are used to put into issues that begin to close up to keep them open longer.

*Issue Plasters.* Ceræ fl. half a pound, minii, tereb. Chiæ, of each four ounces, cinnab., rad. irid. flor. of each one ounce, mosch. four grains; melted, spread upon linen, polished with a moistened calendering glass rubber, and lastly cut into small squares.

2. Diachyl. simpl. one pound, rad. irid. flor. one ounce, spread and polished.

3. Diachyl. simpl. two pounds, pic. Burg. sarcocollæ of each four ounces, tereb. com. one ounce, spread and polished.

*Corn Plaster.* Ceræ fl. two pounds, pic. Burg. twelve ounces, tereb. comm. six ounces, ærug. ppæ. three ounces, spread on cloth, cut and polished.

*Almond Paste.* Almonds blanched four ounces, lemon juice two ounces, oil of almonds three ounces, water one ounce, proof spirits six ounces.

2. Bitter almonds blanched, one pound, white of four eggs, rose water, spirits of wine rectified, of each a sufficient quantity.

*Brown Almond Paste.* Bitter almonds blanched, pulp of raisins, of each one pound, proof spirits a sufficient quantity; cosmetic, softens the skin and prevents chaps.

*Almond Paste.* Amygd. dulc. decoct. one pound, amygd. amar. decoct. half an ounce, sugar one pound, aq. flor. aurant. a sufficient quantity; beat to a paste sufficiently thick not to stick to the fingers.

*Ready made Mustard.* Flour of black mustard seed well sifted from the bran three pounds, salt one pound, make it up with currant wine and add three or four spoonfuls of sugar to each pint.

*Blacking Paste.* Rape oil three ounces, oil vitriol three ounces, mix, the next day add treacle, ivory black, of each three pounds, stone blue six ounces, vinegar a sufficient quantity to form a stiff paste; this will fill one dozen tin boxes.

2. Rape oil three ounces, treacle, brown sugar, each nine ounces; mix, adding ivory black three pounds, flour paste two pounds; when the paste is quite smooth thin it to the consistence of honey with a sufficient quantity of vinger: used for making blacking for leather.

*James' Analeptic Pills.* Pil. Rusi. one pound calc. antimonii lotæ eight ounces, gum guaiaci eight ounces, m. and make thirty-two pills from each drachm.

2. Pill Rusi. pulv. antimonialis, gum guaiaci, of each one scruple; make into twenty pills.

*Anderson's Scotch Pills.* Aloes Bbds. one pound, rad. helleb. nigr. rad. jalapi kali ppi. of each one ounce, oil anise four drachms, syr. simp. a sufficient quantity.

2. Aloes Bbds. two pounds eight ounces, water eight ounces; soften, add jalap sem. anisi pulv. ebor. ustri, of each eight ounces, ol. anisi one ounce.

3. Aloes (Bermudas) one pound, rad. jalap, flour sulphur ebor. ustri, glycyrrh. of each two ounces, oil anise one drachm, gamboge two drachms, sap. castil. four ounces, syr. sp. cervin. a sufficient quantity.

*Ward's Antimonial Pills.* Glass of antimony finely levigated, four ounces, dragon's blood one ounce, mountain wine a sufficient quantity, make into pills of one and a half grains each.

*Steer's Opodeldoc.* Sapo cast. three pounds, spirits wine rectified three gallons, camph. fourteen ounces, oil rorism. three ounces, ol. origani six ounces, aquæ ammon. pur. two pounds.

2. Sap. alb. one pound, camphor four ounces, oil rorism. four drachms, spirits wine rectified two pints.

3. Sap. alb. one pound, camphor four ounces, ol. organ. ol. rorism. of each four drachms, spirits wine rectified q. v. it will bear near six pints.

4. Sap. alb. three pounds, camph. oil. rorism. of each six

ounces, spir. am. camp. fourteen ounces, spirits wine rectified four gallons and a half.

5. Sap. alb. four ounces, camph. one ounce, ol. rorism. two drachms, oil origani thirty drops, spirits wine rectified one pint, water half a pint.

*Squire's Elixir.* Opium four ounces, camphor one ounce, cocind. one ounce, ol. foeniculi dulc. two drachms, tinct. serpt, one pint, spirits anisi two gallons, water two pints, and add aur. musiv. six ounces.

2. Rad. glycy. one pound, kali pp. four ounces, cochineal one ounce, water twelve pints; boil till reduced to one gallon, then add tinct. opii twelve ounces, camphor one ounce, spirits wine rectified four pints, aur. musiv. twelve ounces.

3. Opii one ounce and four drachms, camph. one ounce, coccin. kali. pp. of each one drachm, burnt sugar two ounces, tinct. serpent. one pint, sp. anisi two gallons, aur. musiv. eight ounces.

*Ink Powder.* Green vitriol one pound, galls two pounds, gum Arab. eight ounces: two ounces make a pint of ink.

*Marking Ink.* Lunar caustic two drachms, distilled water six ounces, dissolve and add gum water two drachms, dissolve also natron ppm. half an ounce in water, four ounces, and add gum water half an ounce; wet the linen on which you intend to write with this last solution, dry it, and then write upon it with the first liquor, using a clean pen.

*Red Sealing Wax.* Gum lac two pounds, vermilion four ounces, ol. tereb. ol. olive, of each eight ounces, roll in cakes and polish with a rag till quite cold.

2. Shell-lac five pounds, resinæ fl. three pounds, ol. tereb one pound, vermilion twelve ounces, chalk ppd. four ounces.

3. Resinæ fl. six pounds, shell-lac two pounds, tereb. Venit. two pounds, vermilion eight ounces.

4. Shell-lac, resinæ fl. of each four pounds, tereb. Ven. one pound; add vermilion or bole Armen. ppd. q. p.

*Black Ball.* Beeswax eight ounces, tallow one ounce, gum Arab. one ounce, lampblack q. p.

*Court Plaster, or Sticking Plaster.* Black silk is stained and brushed over with a solution of one ounce of isinglass in twelve ounces of proof spirits, to which two ounces of tinc. Benzoini is added, when dry this is repeated five times more, after which two coats are given it of a solution of four ounces of tereb. Chiaë, in six ounces of tinc. Benzoini, which renders

it less liable to crack ; but some finish it with a simple tincture of black balsam of Peru.

*Lip Salve.* Cera alb. four ounces : ol. olive five ounces ; spermaceti four drachms ; ol. lavend. twenty drops, rad. anchusæ two ounces.

2. Ol. olive opt. two ounces, cera alb. spermaceti. each three oz., rad. anchusæ six drachms ; melt, strain ; add ol. lign. rhod. three drops.

3. Ol. amygd. six ounces, spermaceti three ounces, cera alb. two ounces ; rad. anchusæ one ounce ; balsam Peruv. two drachms.

4. Ol. amygd. spermaceti, cera alb. sacch. canndi albi, of each p. æq. this is white—the others are red.

*Ol. Succini Reductum.* Ol. succin. one pound, petrol bbd. two pounds.

*British Oil.* Ol. tereb. eight ounces, petrol bbd. four ounces, ol. rosm. four drachms.

Ol. tereb. five pounds, asphalt. twelve ounces, ol. lateritiæ eight ounces.

Ol. tereb. five pounds, ol. laterit. ver. eight ounces.

*Huile Antique à la Violette.* Oil of Ben. olives, or almonds, scented with ovia. in the same manner as in making sesenode jas amin, and then pressed out of the wool or cotton.

*Huile Antique au melle fleurs.* Oil of Ben. or almonds, mixed with different essences to the fancy of the perfumer.

## CHAPTER XXXII.

### *Commerce and Manufactures.*

Commerce is the interchange of commodities, or the disposal of produce of any kind for other articles, or for some representative of value for which other articles can be procured, with a view of making a profit by the transaction. The term is usually restricted to the mercantile intercourse between different countries. The internal dealings between individuals of the same country, either for the supply of immediate consumption, or for carrying on manufactures, is more commonly denominated trade. Those who engage their capital in commerce or trade, act as agents between the producers and the consumers of the fruits of the earth ; they purchase them of the former, and sell them to the latter ; and it is by the profits on the sale that capital so employed yields a revenue or income. Commerce or trade increases the wealth

of a nation ; not by raising produce, like agriculture, nor by working up raw materials, like manufactures ; but it gives an additional value to commodities by bringing them from places where they are plentiful, to those where they are scarce ; and by providing the means for their more extended distribution, both the agricultural and manufacturing classes are incited to greater industry.

Agriculture, never arrives at any considerable, much less at its highest degree of perfection, where it is not connected with trade ; that is, where the demand for the produce is not increased by the consumption of trading cities. Though it should be remembered that agriculture is the immediate source of human provision : that trade conduces to the production of provision only as it promotes agriculture ; and that the whole system of commerce, vast and various as it is, has no public importance but its subserviency to this end.

The province of a trader is not so contemptible as some would affect to make it. Many prefer to educate their children for what are called the professions, as law, divinity, and physic, rather than merchandise ; but if such preferment is merely given, as a most likely means of acquiring either honour, preferment, or riches, we will be enabled to convince them in this chapter, their estimation is made by a wrong standard.

Solon, a philosopher and ruler of Athens whose fortune having been reduced by his fathers, as Hermippus informs us, in the indulgence of his great and munificent spirit, though he might have been supported by his friends, yet as he was of a family that had long been accustomed to assist others, he was ashamed to accept assistance and therefore engaged himself in merchandize. Some however have written that this preferment was merely to gratify his curiosity, and extend his knowledge rather than to make a fortune. For he professed his love of wisdom, and when far advanced in years made this declaration, "I grow old in the pursuit of learning." But that he was not excessively attached to wealth we may gather from the following verses—and Plutarch writes, "the truth is, that Solon was never rich ; it may be, because he was always honest."

The man that boasts of golden stores,  
Of grain that loads his bending floors,  
Of fields with freshening herbage green,

Where bounding steeds and herds are seen;  
 I call not happier than the swain  
 Whose limbs are sound, whose food is plain,  
 Whose joys a blooming wife endears,  
 Whose hours a smiling offspring cheers.

Plutarch further states; "It is evident from the writings of this great man that he was a person not only of exalted virtue, but of a pleasant and agreeable temper. He considered men as men; and keeping both their capacity for virtue, and their proneness to evil in view, adapted his laws so as to strengthen the one, and to check and regulate the other."

But that Solon desired to be rich appears from the following lines, found in some of his works.

The flow of riches I desire,  
 And fain would life's true goods acquire;  
 But let me justly them attain,  
 Lest vengeance follow in their train.

A good man and indeed a valuable member of society, should neither set his heart upon superfluities nor reject what is necessary and convenient. And in the times of Solon as Hesiod states, no business was regarded as a disparagement, neither did any trade cause a disadvantageous distinction. The profession of merchandize was honorable, as it brought home the produce of barbarous climes, engaged the friendship, of Kings, and opened a wide field of knowledge and experience. Nay some merchants have been founders of large cities.

Protus, for instance, who built Marseilles, for whom the Gauls about the Rhone had the highest esteem. Thales also and Hippocrates the mathematician are said to have applied themselves to commerce; and the oil which Plato sold in Egypt defrayed the expences of his travels.

It is related that the interest which Thales is said to have taken in traffic, was to show the ease with which riches might be acquired, and foreseeing by his meteorological skill, an abundant crop of olives, he bought the whole produce before hand and made an immense fortune by the speculation.

It was usual to trade into Egypt with the oil of Greece and Judea. It is said in the prophet Hosea (XII, I.) "Ephraim carrieth oil into Egypt." This indeed was the only produce of Attica, which from its abundance, Solon allowed to be exported.

The celebrated Mr. Locke observed, that trade was a surer and shorter way to riches than any other. And after recom-



mending people to bring up their children to some trade, says, if the mistaken parent, frightened with the name of *trade*, shall have an aversion to any thing of this kind in their children, he recommends teaching them merchants' accounts, as a science well becoming any gentleman.

Lord Bacon has observed, "that trade enables the subject to live happily and plentifully, that the country was much enriched by the trade of merchandize," and he stiled the merchants "*Vena porta*," and said, "if they flourish not, a kingdom may have good limbs, but will have empty veins, and flourish little.

The learned Bishop of Cambray, said of the Phœnicians, "trade which they carry to the farthest quarters of the earth, has so enriched them that they surpass the most flourishing people in glory."

And again, instructing Telemachus, how to establish a flourishing trade in Ithaca, "do as those people, receive with kindness and with ease all strangers; and never suffer yourself at any time to be overcome with pride and avarice. Make yourself beloved by all strangers; and even bear with slight inconveniences from them; keep a strict hand over the fraud, negligence, and vain glory of the merchants, which ruins commerce in ruining the traders themselves." The mercantile station affords as large a prospect for opulent acquisitions, and estates got by trade have, undoubtedly, been far more numerous, than those by any other way whatever.

The relation which the merchant stands in to community, is not inferior to any in point of importance. Their zealous attachment to their country, where they have been protected in their commerce, can be fully maintained. History furnishes remarkable instances of this fact. We shall only mention a few, which are sufficient to endear the character of a merchant to every nation.

Charles V. Emperor of Germany having been reduced to great distress by the unhappy expedition of Tunis, experienced a powerful aid in cash from the Fuggers, a single family of merchants only, but at the same time the most opulent and distinguished in Augsburg. To give a demonstration of their zeal to the interests of their country, and their inviolable attachment to his majesty, these merchants requested the emperor, one day as he was taking an airing by their house, to do them the honour to regale himself. When the colla-

tion was over, they desired his permission, to burn a faggot of cinnamon in the hall, where the entertainment was made, not only with intent to administer all they could to his delight, but to give further proof of their affection to his person and government, bound up those bonds of security, which they had taken for their money, with the faggot, and set fire to them before his face.

James Cœur, a merchant of Bourges, by the wisdom of his counsel, and the certainty of his cash, humbled the house of Burgundy, secured the crown of France to the lawful heir, Charles VII. and by him to the branches of Valois and Bourbon, who succeeded.

The merchants of St. Malo, being highly exasperated at the demand made at the Congress of Gertruydensburg to Lewis XIV. to employ his troops to compel his grandson Philip V. then King of Spain, to abandon the crown, united all their profits together, which they had made in the Spanish Colonies of America, and produced thirty-two millions of gold at the foot of the throne: and at a time when the finances of France were totally exhausted by a series of unsuccessful events. This succour being timely applied, vigorously renewed the war, and answered the wishes of the nation.

Sir Thomas Grèsham, the founder of a college in London, for the promotion of the liberal arts, and of the Royal Exchange, for the convenience of the traders of the metropolis, is another instance of the ability of private merchants to support government under the greatest emergency. This worthy citizen of London lived in the time of Edward VI. who was considerably indebted to the merchants of Antwerp, for money borrowed to supply the exigencies of the state. The payment of the interest, at that time, being considered as most likely to embarrass the country, many expedients were projected by the king and council, to discharge those debts: which were, either to transport so much treasure out of the country, as would liquidate them, or remit the same by way of exchange. The former was impracticable without being ruinous to trade; and on account of the difference of exchange, the latter appeared equally perplexing. Besides, the creditors insisted on their money, or a compliance with such usurious terms, as would have brought the greatest indignity upon the nation. Under these circumstances, Sir Thomas undertook the affair, and by his great knowledge and skill in

the exchanges, exonerated the nation from the incumbrance; and by which negotiations, the king saved not less than an hundred thousand pounds. By raising the exchange in favour of England at this critical time, the price of all foreign commodities fell proportionably; and in a very little while between three and four hundred thousand pounds sterling more was saved to the nation. With Queen Elizabeth, he was in so high esteem, that she knighted him, and honoured him in every respect, and came in person to the *Exchange*, which he had erected for the convenience of merchants, and the honour of the city of London, and caused the same to be proclaimed by heralds and a trumpet, the *Royal Exchange*, and Sir Thomas was afterwards honoured by the appellation of *royal merchant*.

The building has been described as a stately pile, which was burnt down in 1666, but was rebuilt, and is now represented, as built of the most beautiful stone, stupendous and elegant arch work, all of the most curious and admirable architecture, together with its high tower in which are hung a harmonious chime of twelve bells rendering it the noblest structure for a meeting place for merchants in the world.

Thomas Sutton, Esq. another distinguished English merchant, and founder of the Charter House in London, did an act of benevolence worthy of a great prince a few years after the death of Sir Thomas Gresham, in being the grand instrument of getting the Spanish bills protested at Genoa, which retarded for a whole year the sailing of the Spanish Armada, designed to invade England; by which means the plan was defeated. Thus we learn the worth of some private merchants; and although great statesmen, admirals, and generals, with the aid of the public purse, and ten thousands to co-operate with them, may perform great achievements, yet we find that one family of merchants has been the support of an emperor in great distress; another single merchant, gave the crown to the house of Bourbon; that one was the principal cause of defeating the Spanish Armada; and another, the restorer of the public credit of England. Nor has the security of states and empires been only owing to the occasionally zealous exertions of the wisdom and power of the merchants, but they are in a great measure the daily and perpetual support of all trading countries.

For, as nations are at present circumstanced, those which are so situated, subsisting chiefly within themselves, without

any intercourse or commerce with others, can never be able to maintain so great a share of power, as those which carry on an extended foreign traffic. Domestic trade, only shifting property from hand to hand, cannot increase the riches and power of a nation; whilst foreign trade under wise laws and regulations, bringing in a constant balance of treasure in favour of a nation, will proportionably augment its weight of interest, and at length give it the balance of power.

Our own country, though in commercial infancy can boast of many specimens of mercantile worth. Who has not heard of the private and public virtues which adorned the character of a Phillips, a Gray—and though it is not fashionable to eulogize the living, still we cannot forbear adding a Gerard. Yes, many, very many families, many widows and orphans, have so often felt their charities, that exclusive of the many great and important services which they have rendered their country, tables of stone are not needed to tell the passing stranger, ‘they went about doing good.’ Truly, are not such men to be estimated as the gold and silver, the most intrinsic if not appreciated coin of any country—while it should be deprecated that others perhaps of equal wealth, like the Jew in Shylock—live only to count their increased gains, and throw a deadly blast, throughout every region which becomes subject to their *sweeping* avarice, or unhallowed disposition—What a fit subject for the artist pencil!

The merit of persons of distinguished character in trade, cannot, in general, be measured by those who are not well acquainted with trading negotiations; as they pass through life without much noise, the world is little acquainted with their important services and utility to the state.

Whilst the histories of great public capacities are transmitted to posterity with all the pomp and magnificence of representation: yet certainly that is one of the most profitable admonitions, which is drawn from the eminent virtues of men, who move in a sphere nearer levelled to the common reach, than that which is derived from the splendid portrait of the transactions and victories of great statesman and commanders, which serve but for the imitation of few, and aim rather for ostentation, than for the true instruction of human life. It was from the practice and example of private condition, that we are more naturally taught to excel in our private capacities; and, had we the genuine histories of many

eminent merchants, giving a lively idea of their rise and progress in business, and of the important service they have been to their respective communities, they would naturally incite the trading class of community to emulate their accomplishments: and this would prove a more effectual means to produce a race of skilful traders, than romantic narratives of a race of heroes.

The philosopher may arrive to a high pitch of improvement in agriculture, arts and sciences; the husbandman, artisan and manufacturer, may reduce this speculative knowledge to practical uses, with the greatest skill and dexterity on their parts; governments may enact the wisest laws, and give all desirable encouragement to commence, yet what will these avail without the penetration and sagacity of the merchant, to propagate the produce of our lands, and the labour of our artists and manufacturers into foreign countries, with advantage to the state as well as to himself?

Sir F. Brewster, an eminent English merchant, observed, "we see how all the arts and science have improved in this country, with in the compass of one century, but amongst them all the merchant's part the least." And further, that any countryman but our own, would be astonished to observe more heads engaged in Westminster hall, to divide the gains of the nation than there are heads on the Exchange to gather it. And further, he says, "I think it a moral-distemper that so few men of classical learning are educated to practical commerce: for there is scarcely a boy, whom a country school master flatters, because he learns his grammar well, whose kindred do not think it a pity so hopeful a youth should be lost in trade, and that the university is the only fit soil for him to be planted in."

We do not introduce these remarks of Sir Francis as applicable to this country, for we do rejoice in the belief that its mercantile character is increasing in dignity, that young men of the most promising talents are embarking in merchandize, and that the feeling which hitherto was so unnaturally excited against it, has nearly subsided.

We believe that there is a dignity or as some will have it a respectability of character to be sustained in all professions; though—

"It is a matter of curious investigation, to examine the distinctions which society has made, amongst the different trades

and professions. 'A saint in crape is twice a saint in lawn,' says Pope; and yet he tells us, 'that honor and shame from no condition rise;' the latter is true by the laws of nature; the former by the usages of society.

Whether a lawyer is more respectable than a doctor, or a merchant than a farmer, is a question that has not yet been settled by her high mightiness, *Fashion*; but with respect to the different pursuits of trade, she has drawn the distinction, having consulted neither reason or rhyme, and governs solely by her own whims. A butcher, for instance, is considered as superior to a baker;—and why? They both cater for the appetite of man: one furnishes the slaughtered calf, and the other the generous grain, which alike support life; one deals in fire, and the other in sword; are they not on a par? A shoemaker is more respectable than a cobbler;—why? one makes your shoes, and the other mends them—they both use awls and waxed ends; where is the difference?

"Is a hatter more exalted than a tailor? The one covers 'the dome of thought, the palace of the soul!' his vocation is certainly of the head; he surmounts the crown; but then the tailor adorns the graceful form and manly chest; the waistcoat that he makes covers the heart, the seat of sensation and the abode of passion. He makes you either a gentleman or a clown, according to his will. You are at his mercy with regard to the fit of your habiliments and the effect of your appearance in Broadway. Thus extensive is his power; and is not power respectability? A milliner is more respected in society than a mantua-maker; the one makes hats and the other dresses. Why is a female hatter greater than a female tailor? Why is a grocer considered inferior to a seller of dry goods? Is not a bottle of mustard as respectable as a yard of tape? Is not a pound of cheese as honourable as a paper of pins? A bunch of onions as a skein of thread! Is not sugar equal to broadcloth, and molasses to ginghams? Certainly.

"Again, why is a saddler superior to a shoemaker? He covers the backs of horses, while the latter covers the feet of men. And is not the foot of lordly man and lovely woman, an object of greater moment than the back of Eclipse himself? How and why then are these distinctions made? It is easier to ask than to answer the question; to do the latter, surpasses our wisdom. But are these distinctions reasonable and natu

ral? No. Honest industry is alike respectable in every vocation. The faithful mason, who piles one brick upon another, is the equal of him who makes the bricks, or him who burns the lime which is used in making the mortar; [and we may add, or him for whose comfort his labour is destined to effect.] The industrious mechanic is the prop of society, and so long as he labours diligently and honestly in his occupation, he is entitled to respectability and he will receive it." Nevertheless, it must be acknowledged, and to the degradation of human nature be it said, there are many in all professions, dishonouring them by the flattery of some, and their own unnatural conceit.

*Channels and Progress of Trade.* England possesses 30,000 miles of roads, nearly 4,000 miles of canals, and about 300 miles of railways. France, which is more than twice as extensive, does not afford above 45,000 miles of roads, 1500 miles of canals, 114 miles of railways, of which latter 78 are still in a course of completion.

The amount of Tobacco imported into Great Britain the last year was 33,0000,000, twenty-two of which was from America, and almost exclusively in American shipping.

*Whale Ships.* The ship Pacific, recently from the Pacific, has arrived at New Bedford with about 3,000 barrels of whale oil, which is considered to be the largest quantity of spermaceti oil, ever obtained in a twenty-six months voyage.

*Coal.* Thirty-five thousand three hundred and sixty-two tons have been discharged at Philadelphia, the present season, brought down the Schuylkill. The amount of coal sent down the Lehigh is 4,956 tons. And it is hoped 99,000 tons will be received in that city before navigation closes. Only a few years since we were dependent on England for this valuable article.

*Tea.* The first order of the East India Company to their agents in India, for the importation of tea, appears to have been made 1667, and is in these words:—"To send home by these ere ships, 100 lbs. weight of the best Tea you can get." The quantity put up for sale by the Company at their quarterly sales in June, 1829, was 7,800,000 lbs.; and at the preceding sales of September, December, and March, 7,900,000, 800,000,000 and 900,000,000. The duty to government the last year was £3,283,202—considerably more than was produced by any other article of consumption in England.

*Depression of Trade.* The following article extracted from a Boston paper is worthy of being read with attention as applicable to the present times.

"The truth unfortunately is, we have been living beyond our circumstances. The laudable economy and industrious habits of our ancestors, have been lost sight of, and we have yielded up to the pleasing, but dangerous innovation of foreign luxuries, and their attendant habits. We must measure back our ground. There is no other course which we can now pursue with any hope of success. The flame must again be kindled on the altar of patriotism; and self denial and rigid economy take the place of luxury and extravagance. The nerves of our effeminate young men must be strengthened by toil, and our females, instead of reclining on the sofa, and humming over the piano, must learn to direct their attention to matters of more importance. They must shake off, an unworthy the daughters of freemen, the tinsel of fashion, and the shackle of false refinement, and cherish the proud and sterling patriotism of their grand mothers."

Manufactures are the arts by which natural productions are brought into the state or form in which they are consumed or used. They require in general great expenses for their first establishment, costly machines for shortening manual labour, and money and credit for purchasing materials from distant countries. There is not a single manufacture in Great Britain which does not require, in some part of its process, productions from different parts of the globe. It requires, therefore, ships, and a friendly intercourse with foreign nations, to transport commodities and exchange productions. They would not be a manufacturing, unless they were a commercial nation. The two sciences which most assist the manufacturer, are mechanics and chemistry; the one for building mills, working mines, and in general for constructing machines, either to shorten the labour of man by performing it in less time, or to perform what the strength of man alone could not accomplish; the other for fusing and working ores, dying, bleaching, and extracting the virtues of various substances for particular occasions.

It must be observed that though a farmer does not so frequently and rapidly amass wealth as a merchant or manufacturer, yet neither is he so often ruined. The risks a man encounters in trade are much greater than in farming. The



manufacturer, as well as the merchant is liable to severe losses arising from contingencies in trade; they both must therefore have a chance of making proportionably greater profits. The chances of gain must balance the chance of loss. If he be so skilful or so fortunate as to make more than his average share of gain, he will accumulate wealth with greater rapidity than the farmer; but should either a deficiency of talents or unfortunate circumstances occasion an uncommon share of losses, he may become a bankrupt. The rate of profits, therefore, upon any employment of capital, is proportioned to the risks with which it is attended; but if calculated during a sufficient period of time, and upon a sufficient number of instances to afford an average, these different modes of employing capital, will be found to yield similar profits. It is owing to this that the distribution of capital to the several branches of agriculture, commerce, and manufactures, preserves a due equilibrium, which, though it may be accidentally disturbed, cannot whilst allowed to pursue its natural course, be permanently deranged.

An abundant harvest may occasionally raise the rate of agricultural profits, or a very bad season may reduce them below their level.

The opening a trade with a new country, or the breaking out of a war, which impedes foreign commerce, will effect the profits of the merchant and manufacture: but these accidents disturb the equal rate of profits, as the wind disturbs the sea; and when they cease, it returns to its natural level.

The division of labour has tended greatly to improve every branch of manufactures. Its utility is exemplified in the manufacture of pins. If a piece of metal were given to a man to make a pin, he could scarcely do it in a day. In pin manufactories, however, each pin passes through twenty-five hands; one draws out the wire, another straightens it, another cuts, another points it, three or four prepare the head, two or three puts it on, &c. Twenty-five persons thus make a hundred and twenty-five thousand pins in a day, or five thousand to each person. Labour likewise divides itself numerously in every branch of the elegant and useful arts, as in building, the arts connected in furnishing a house, in branches connected with the clothing of a man, in the iron and metallic trades, and in connexion with books and literature.

A pack of wool weighing 240 pounds employs 200 persons

before it is ready for sale, in the form of stuffs, cloths, &c. To be made into stockings, it will occupy 184 persons for a week; as ten cumbers, one hundred spinners, winders, &c. sixty weavers or stocking makers, besides dyers, pressers, &c. A sword made of steel, the original metal of which was not worth a shilling, is sometimes sold for 300 guineas; and a watch chain has produced fifty-guineas, the metal of which before it was wrought, was not worth three pence. So likewise, a painting, not two yards square, has been valued at 25,000 pounds sterling; and a shawl, which contained but a few ounces of wool, has been said to bring 150 guineas. As it is with individuals, so it is with nations. What one possesses in superfluity, it is desirous to exchange for some article it wants, with any other nation which possesses that superfluity.

The Phœnicians, or Philistines were the first people on record, who employed ships to carry the produce and manufactures of one nation to another. They were followed by the Carthagenians; and these by the Venetians, Genoese and Hanse Towns. The United States of America, with the advantage of the possession of raw materials of every kind, are rapidly advancing in the manufacturing system; having numerous fine ports and ships, and a trade extended to all parts of the world, with these advantages connected with the enterprise, perseverance and industry of our merchants, manufacturers and mechanics, who can doubt the time is not far distant, when this country will rival every other on the whole face of the globe in commerce and manufactures.

*Progress of Manufactures.—Late discoveries &c.*

*Flint Stone Ware.* The manufacture of this article is very extensively carried on, by Mr. Henderson of Jersey City, opposite New-York. It is equal to the best English and Scotch stone ware, and will be supplied to the trade at 33.1-3 per. ct. less, than like foreign articles, when imported.

*China Ware,* Beautifully painted and enammelled, is now extensively manufactured at Philadelphia by Mr. Tucker, who has been struggling with many difficulties for a long time, but at length as we are informed, has so far overcome them as to produce very superior articles at moderate prices.

*Iron.* The quantity of this metal manufactured in Franklin, Venango county, Pa. in 1828, 1600 tons, of bloom; 200 tons, of bar iron 100 tons. The pig metal sold at Pittsburg,

Wheeling and Steubenville at from 35 to 40 dollars pr. ton. The blooms at Pittsburg \$100 pr. ton, and the bar iron at the the works, at from \$125 to \$140 pr. ton.

Several new furnaces are erecting it is said in the county and the demand rapidly increasing.

A Furnace with proper management will make from 800 to 1000 tons per annum, at an expence of from \$22 to \$25 per ton, according to the price of provision ; and with the ore, timber, &c. convenient and good at about from 13 to 20 dollars.

Under proper management and good materials, a furnace will clear at present prices, ten thousand dollars per annum.

*Lead and Silver Mines.* A lead. or rather silver mine has recently been discovered in the Town of Eaton in New Hampshire. A shaft has been sunk into the mine 50 feet below the surface, and a horizontal excavation running from the bottom about 50 feet more, has been made.

The ore already raised amounts to several hundred tons, the expence of obtaining which, does not exceed 3 or \$4000 and from several analyses of different kinds of the ore, then were found to be from 90 to 120 ounces of pure silver to the ton.

It is understood to be owned principally by a company of gentlemen in Boston and Baltimore.

*Upper Mississippi Lead Mines.* Congress seeing that immense quantities of lead were made and could be manufactured in these mines, and those below, sufficient for home consumption, very justly added to the duties which had already been imposed on lead, a per centum amply sufficient to prohibit any further importation. This law passed in the winter of 1828, but took effect not until the following October. During this interim, advantages were taken by the British merchants and large quantities of lead were imported into the United States, nearly enough for one year's supply ; and since the law took effect, about eight millions pounds of lead in the ore have been imported from the mines of Spain, and smelted in the United States. This, added to the unusual quantity brought between the time of the passing of the law above mentioned, and its taking effect, together with the immense quantity manufactured in our mines during the same period, every man must perceive would fill our markets with a surplus, which readily accounts for the sudden depreciation

in the price of lead. Instructions have been given to the custom house officers in the eastern cities, to charge an equivalent duty on imported lead ore. Hence, that mode of importing lead is at an end; so we may now safely calculate that we can supply our own country, at least, from our own mines. The diminution in our manufacture in consequence of the low price of lead, will no doubt before another year, render that article very scarce in the eastern markets. There will not during the present year, be one eighth the quantity made, that there was during the two preceding. Then deduct seven-eighths from the quantity usually made at our own mines, and all that has been in our markets during the last year or two, and we can form some idea of the future state of the market. The consumption of lead in the United States, according to the best data which has come under our observation, amounts to about 26,000,009, of which more than half of that quantity for the last year has been imported; and during the same period there were about 10,000 miners in the Upper Mississippi actively engaged in the manufacture of lead. It is not strange then, that such extraordinary exertions of our own industrious citizens, and the strong efforts of foreigners to crowd lead into our markets, should produce a temporary stagnation in this trade. But these two powerful causes have been removed; and it must and will as suddenly rise as it has fallen, the expressed opinion of speculators to the contrary notwithstanding.

*Penknife Manufactory.* Mr. Moses L. Morse, an ingenious mechanic, and the inventor of several valuable machines, has commenced the manufacture of Penknives in Worcester, Mass. and intends to employ 50 hands, they are well made, with a high polish, and unless examined very closely, it would be difficult to distinguish them from the English knives.

*Ingenious Discovery.* A Mr. Neilson of the Glasgow gas works, has recently obtained a patent for an apparatus, which discharges air and promotes combustion in fire furnaces, by being heated before it is thrown into them. A series of experiments has been going on for sometime on founders cupolas, and in the blast furnace of Clyde iron works, as stated in the Baltimore Gazette, where one furnace has been blown with great advantage by means of heated air, and where other two blast furnace are ready to be blown in the same way.

It is completely ascertained that a great saving of fuel is

accomplished, besides, sanguine hopes are entertained, that the same work will be done with a less quantity of air. This discovery will effect a great revolution in the theory, as well as practice of combustion.

*Screw Manufactory.* Mr. Cobb of Albany, has recently made great improvements in the machinery for the manufacture of this important article. We believe this gentleman was the first who introduced the manufacture of wood screws into this country; though it has been claimed by a Mr. Stowell of Massachusetts. He is certainly entitled to much credit not only as a scientific but practical mechanic. If improvements equally as valuable are made in every branch in this country; our manufactured goods will be preferred, and the English manufacturer will find his articles no longer sought for in this quarter of the globe.

*Machinery for breaking and dressing Flax and Hemp.* The following is a description taken from the Asylum of Arts in France, by a gentleman friendly to the agricultural industry of the United States.

"This machine was invented by a French gentleman, under the offered bounty of Napoleon of 1,200,000 francs, about the year 1814, description as follows: 50 to 88 pairs of fluted rollers, the top roller hiding them of the bottom, and each pair lying by the side of each other, so closely as not to receive the flax or hemp from one pair to the other, untill it passes through the whole range. At the end of every bottom roller, there are pinion wheels, and wheels at right angles to drive them, and the latter set in motion by the former given at the head of the machine. The top rollers are lever weighted on the bottom rollers, and the latter gives motion to the former, by the said motion at the head of the machine. The rollers lie in a horizontal position, their ends leaning or resting in stands, and their whole range forming a level flat surface upon the top, as well as the bottom. The machine has two openings, one for feeding and the other for receiving the hemp after dressed, &c.

It is said that the machine will break and dress 2000 lbs. pr. day and will take 10 hands to tend it to advantage."

We have a promise from the same source, of shortly having a description of the Linen spinning, "although complicated with needles and rollers, yet it may answer on small scales." "It appears" says he, "has never been effected to that sin -

plicity, and facility of operation, as that of cotton, and if ever found out it must be by an American, as centuries have passed away in Europe without the discovery."

*Perpetual Motion.* A Mr. Brigham has recently appeared at Cincinnati, as the discoverer of the perpetual motion—which is "a pendulum set in motion by a magnet, and appears admirably calculated for clock work, and we can see no cause why it should not continue to go so long as the materials of which it is made shall last. It is well worthy the attention of the curious, particularly those skilled in mechanics."

*Turkey Red.* The use of Turkey red in calico printing has been successfully introduced at Lowell. The French have long had an advantage of the English in the employment of this colour.

We should notice many other important and useful inventions, if our limits permitted, which we design to do at some future period in another edition of this work, not only noticing every recent improvement in this country, but also, in Europe, so far as our knowledge may extend.

*On the reported distress among the manufacturers,* we think the following remarks with some slight alterations, worthy of insertion, from Nile's Register:—

Perhaps there is no class of community more sinned against than the manufacturers. They are represented as may best suit their enemies—as overgrown capitalists, living on the labour of the poor, as needy adventurers who may involve the whole country in ruin.

While it must be admitted that many branches of those manufactures have not been profitable for some time past—it appears to be manifest that the difficulties under which the eastern manufacturers have laboured were consummated by a sudden and ruinous contraction of the *circulating medium* in that quarter; for it is no less remarkable than true, that others, less favourably circumstanced, have, with apparent ease, resisted or repelled this pressure, and maintained a full and uninterrupted operation, in the midst of sacrifices of goods by forced sales. But, if they can "keep steady" a little while, time enough to permit the business to settle down into its natural state, as it must, all will be well, and an enlivening circulation soon be felt and enjoyed.

No one thinks of proclaiming through the land the misfor-

times of the merchant, when arrested in his business—unless influenced with a spirit of deep felt sympathy and accommodation—and this is as it should be—but on the other hand, when the manufacturer fails, all sorts of dogs of British breed are let loose upon, bark at him, and would bite his heels if they dared. Their noise, however adds to the difficulties encountered, and hence forced sales of property, and the necessity of curtailing the progress of expenditure. But such things have happened before. They cannot be altogether avoided, even by the most prudent, and especially so long as our commercial intercourse is so intimate with the old world, particularly Great Britain: for a pressure in Lancashire or Yorkshire reaches the United States almost as soon, and with nearly the same force, as it reaches the southern or more northern counties of that small island; and our market is made the *last resort* of desperate speculators, insolvent persons, or for closing up concerns; which it is desired to accomplish speedily, though attended with loss. And whenever a pressure comes upon us, there is a sudden reduction of the circulating medium—the bank of the United States gathers in its strength, and the state banks reserve their's for self preservation, and individuals whose credit was good for thousands yesterday, may be unable to raise a few hundred dollars tomorrow; and the failure of one person to fulfil his engagements, proceeds through a community to an incalculable extent—reaching the most wealthy as well as the poorest of the labouring classes—though some districts are more effected by such actions and reactions than others.

All manufacturers at the present time, are effected in some degree, by the general dullness of business. We believe that the cotton business will very soon revive, and hope that all will be encouraged to hold their ground, notwithstanding we are informed many “respectable establishments have ceased their usual business,” neither be alarmed, though much is said “of reduced prices” and “pinching times” and “scarcity of money”—for such things have been said, if not felt, before—and unless it be in the growth and manufacture of wool, there is good reason to believe that the storm will speedily pass over; and in respect to those important branches, *any* change in the present condition of Europe must operate advantageously for them; for “when things get to their worst, they must mend.” The long continued state of peace among

the nations with whom we have the most intimate connections, after such a long period of war, has not only materially altered their relations one with the other, but placed the United States under *new* circumstances, to which we shall not be reconciled, until the generations of men who commenced business at the breaking out of the French revolution shall have ceased to influence the public mind.

A little while ago we were the merchants and carriers for millions of persons, whose own merchants now do their own business, in their own ships, and labour has necessarily sought new occupations. These are not adjusted and settled as they will be in due time : and are obstructed too, by a constant recurrence to opinions and rules of action established, when nearly all Europe was in a state of war, entirely inapplicable when Europe is in a state of peace. The want of sensibility as to these things, has greatly contributed to bring about those seasons of adversity through which we have passed.

The manufacturers are component parts of the trading community ; and, if the proportion which they bear to the whole of that community were ascertained, it would not be found that failures among them are more frequent than to other classes of that community.—They are liable to the various fortunes of all dealing men—at one period depressed, at and another, prosperous.

Scarcity and abundance effect them like others. The makers of low priced cottons are embarrassed just now, but their business will soon regulate itself and time will provide a remedy. The woollen manufactures are reviving. I do not think that the tariff of 1828, has been yet fully tested, and the state of things in England has tended to distract what may be called its regular operation.

We have not yet got over the heavy importation of 1827-8 and the very low price of wool at present in England influences the price in our market.

So long as the effects of bankrupts in Europe are sent to this country for forced sales, that their accounts may be closed, our markets must be variable, but with increased experience we shall not be so much embarrassed by that variability as we have been.

Let not the friends of American industry be discouraged. Let them carefully investigate the facts that belong to their several concerns, and prepare for the approaching conte



(the opposers of the tariff.) My opinion is, that no change of the present law, should yet be asked for. There are certain things which must "regulate themselves" among them, the growing as well as the spinning of cotton.—The planters will severely discover this at an early day. Even the present low prices cannot be paid on the present price of goods manufactured from it.

The fact that some, too many of the manufacturers, were straightened to meet their obligations, has had a more extended and ruinous tendency from an idea that the protecting system would be abandoned at the next session of Congress—we do not believe in such a result. We think there is force enough to resist the resolution to effect the destruction of this system—but the apprehension of it has been, and still is rendering incalculable mischief to the United States.

## CHAPTER XXXIV

### *Laws Relative To Spirits, Wines, Teas, &c.*

#### *Extracted from Ingersoll's Digest.*

25. Sec. XLI. The surveyor or chief officer of inspection, shall give the proprietor, or consignee, of any distilled spirits, wines or teas, or his or her agent, a particular certificate, which shall accompany each cask, chest, vessel, or case, of distilled spirits, wines, or teas, wherever the same may be sent within the limits of the United States, as evidence that the same has been lawfully imported. Form as follows:

No.                      District of ———, Port of ———.

I certify that there was imported in this district, on the [here insert the date of importation] by [here insert the name of the proprietor, importer, or consignee] in the [here insert the name of the vessel, the surname of the master, and whether a vessel of the United States, or a foreign vessel] from [here insert the place from which imported] one [here insert whether cask, chest, vessel or case, by the proper name] of [here insert whether spirits, wines, or teas and the kinds of each] numbered and marked as per margin; [the marks of the inspector to be inserted in the margin] containing [here insert the number of gallons, and rate of proof, of spirits, or gallons, if wines, or number of pounds weight net, if teas.]

A. B. Supervisor.

Countersigned by C. D. Inspector.

26. Sec. XLIII. The proprietor, importer, or consignee or his or her agent, who may receive said certificate, shall, upon the sale and delivery of any of the said spirits, wines, or teas, deliver to the purchaser or purchasers thereof, the certificate or certificates which ought to accompany the same on pain of forfeiting the sum of fifty dollars for each cask, chest, vessel or case, with which such certificate shall not be delivered: and if any casks, chests, vessels or cases containing distilled spirits, wines, or teas, by the foregoing provisions ought to be marked and accompanied with certificates, shall be found in the possession of any person unaccompanied with such marks and certificates, it shall be presumptive evidence that the same are liable to forfeiture; and it shall be lawful for any officer of the customs or of inspection to seize them as aforesaid; and if upon trial, the consequence of such seizure, the owner or claimant of the spirits, wines, or teas, seized shall not prove that the same were imported into the United States according to law, and the duties thereupon paid, or secured, they shall be adjudged to be forfeited.

27. Sec. XLIV. On the sale of any cask, chest, vessel or case which has been, or shall be marked pursuant to the provisions aforesaid as containing distilled spirits, wines, or teas, and which has been emptied of its contents, and prior to the delivery thereof to the purchaser, or any removal thereof, the marks and numbers which shall have been set thereon by or under the direction of any officer of inspection, shall be defaced and obliterated in the presence of some officer of inspection or of the customs, who shall, on due notice being given, attend for that purpose, at which time the certificate, which ought to accompany such cask, chest, vessel, or case, shall also be returned and cancelled; and every person who shall obliterate, counterfeit, alter, or deface any mark or number, placed by an officer of inspection upon any cask, vessel, or case, containing distilled spirits, wines, or teas, or any certificate thereof; or who shall sell, or in any way alienate or remove any cask, chest, vessel, or case, which has been emptied of its contents, before the marks and numbers set thereon, pursuant to the provisions aforesaid, shall have been defaced or obliterated, in presence of an officer of inspection as aforesaid; or who shall neglect or refuse to deliver the certificate issued to accompany the cask, chest, vessel, or case, of which the

marks and numbers shall have been defaced or obliterated, in the manner aforesaid, on being thereto required by an officer of inspection or of the customs, shall for each and every such offence, forfeit and pay one hundred dollars, with costs of suit.

124. Sec. XIX. When any goods, wares or merchandize, shall be admitted to entry upon invoice, the collector of the port in which the same are entered, shall certify such invoice under his official seal; and no other evidence of the value of such goods, wares, or merchandise, shall be admitted on the part of the owners thereof, in any court of the United States, except in corroboration of such invoice

125. Sec. XX. Any person or persons, who shall counterfeit any certificate or attestation made in pursuance of this act, or use such certificate or attestation, knowing the same to be counterfeit, shall upon conviction thereof, before any court of the United States, having cognizance of the same, be adjudged guilty of felony, and be fined in a sum not exceeding ten thousand dollars, and imprisoned for a term not exceeding three years.

127. XXII. The collector of the customs shall be required to cause one package at least out of every invoice, and one package at least out of every fifty packages, of every invoice of goods, wares, or merchandise, imported into their respective districts, to be opened and examined, and if the same be found not to correspond with the invoice thereof, or to be falsely charged in such invoice, a full inspection of all such goods, wares, or merchandise, as may be included in the same entry, shall be made; and if any package is found to contain any article not described in the invoice, the whole package shall be forfeited; and in case such goods, wares, or merchandize, shall be subject to an ad valorem duty, the same proceedings shall be had, and the same penalties shall be incurred, as in the eleventh section of this act: provided that nothing herein contained shall save from forfeiture any package, having in it any article not described in the invoice.

## CHAPTER XXXV.

### *Credits.*

None will deny, that every considerable trader ought to have some stock, or cash capital of his own; the most judicious traders, like bankers, are always careful to keep their

dealings within the extent of their capital, that no disappointment may incapacitate them to support their credit. Yet traders of worth, judgment and economy, are sometimes under the necessity of borrowing money, to carry on their business to the best advantage; as when the merchant has commodities on hand, which he wishes to keep for a rising market, or on account of monies accruing to him, which he is disappointed in receiving. On occasions like these, taking up money at interest, is not disreputable, but a great convenience; thus enabling him to carry on his business more successfully; but the borrower ought to be well assured, that he has sufficient effects within his power to liquidate the obligations in due time.

But, if the trader borrows money to the extent of his credit, and launches out into trade, employing it as his own, such management is extremely precarious, and is generally attended with the most preposterous consequences: for trade is subject to losses and disappointments; and when once a trader brings his credit into doubt, it may and will draw all his creditors, at the same time, upon him; consequently rendering him incapable of drawing in so much of his scattered effects as will discharge his debts, and thereby ruin his credit, although he might have believed he had more than enough to satisfy the whole world.

As, therefore, a wise man will trade so cautiously, as not to hazard the loss of his own proper estate at once, much more, should an honest man be careful not to involve the estates of others, in his personal trading adventures. But he that knows he has lost his own fortune, and endeavours to recover it by trading with the stock of other men, although he may be actuated by good motives, still cannot have a pretence to the character of being judicious. The dealing for goods on a credit, was, probably, at first introduced, by trusting young men commencing in trade, whose chief, and perhaps only stock, might be the opinion of their capacity, industry, and honesty: and as this is continued to retailers, and those who trade on a small stock, it may be reckoned a commendable, and useful practice; but whether the practice of this liberality should be extended to the wholesale trader, in so unlimited a manner, as is customary in most of our trading cities, is a consideration which admits of great doubt. This maxim may, however be advanced with some confidence, that a mer-

merchant should never purchase goods on short credit, with intent to meet the time of payment by remittances from cash sales of the same goods, as consequences might follow, not only ruinous to those who try the experiment, but injurious to trade in several ways. Under such circumstances, the trader finding his expectancies failing, is induced to offer his articles at reduced prices, as a last resource from impending ruin; but ten to one, and a most fortunate occurrence, if he does not find his financial system on the debit side of profit and loss. There may be, and certainly are, cases when a merchant may be justified in forcing sales, though it has ever been found, as a *general principle*, unwise; it disturbs the whole current of trade, and drives it out of its natural channel; hundreds falling into the stream, in this way, float among breakers, and finally split on rocks, or are cast on quicksands, hardly ever to be recovered. The forcing of trade produces a general introduction of goods of an ordinary quality. Is it not a fact, that when one among a number of traders, introduces a financial trade, his neighbours are induced to replenish their stock with inferior articles (in order to retain their customers,) which will afford them the same profit at less prices, as when accustomed to keep prime articles; and after obtaining the reputation of selling goods of indifferent quality, other places receive the trade, which otherwise might not have been thus imprudently lost?

"Cheap Stores" are not always found to have the cheapest goods, if we reckon by *principles of profit* to the purchaser; for the qualities of most goods correspond with the prices. It is observable that those merchants generally succeed the best, who have the reputation of keeping prime articles, and are not so very tenacious of acquiring the fame of selling remarkably cheap.

It is no doubt to be considered an established principle among traders, when they have occasion to make use of their credit, it should be for the borrowing of money, but never for the buying of goods; thus enabling them to purchase at the best possible advantage.

There is another evil in trade, which we have seen and which we believe deserves some consideration. Some traders exhibit a wonderful degree of diffidence or modesty, fearing to offend, in collecting their dues; particularly, when they are against persons of acknowledged responsibility, who cer-

tainly ought to be the most prompt, and willing as they are most enabled to make their payments. It could be said many, and very many merchants have suffered on this account.

But is it often the case, that the debtor under such circumstances is unwilling to avail himself of the advantage thus offered? However such customers may consider the subject, certainly, they are not to be estimated among the number in building up a shopkeeper. It is an acknowledged fact, that gentlemen of estates generally require those articles which the traders esteem as *cash goods*; that traders who reside at some distance from the city, could have sold all such goods which they dispose of on a credit *for cash*, before they can replenish? We speak of those who do not keep heavy stocks, though, perhaps, it might be applicable in some cases; but is it not a matter worthy of examination, if an unforced and natural business, effected with cash, or short credit, does not produce, ultimately, more actual gain, than that which is more extended, and on long and unlimited credits? Those who have been in trade a great number of years, can, perhaps, answer the question satisfactorily.

*"Hints to Mechanics."*

Avoid giving long credits, even to your best customers. A man who can pay easily, will not thank you for the delay; and a *slack, doubtful* paymaster is not too valuable a customer to *dun sharply* and *seasonably*. A fish may as well attempt to live without water, or a man without air, as a mechanic without punctuality and promptness in collecting and paying his debts. It is a mistaken and ruinous policy to attempt to keep on and get business by delaying collections. When you lose a slack paymaster from your books, you only *lose* the chance of *losing* your money—and there is no man who pays more money to lawyers than he who is least prompt in collecting for himself.

"Take care how you agree to pay money for your stock, your provisions, your rent, or your fuel, and take *dog skins* for your work. One hand must wash the other, as poor Richard says, or both will go to jail dirty. Every man's trade ought to bring him money enough to pay all demands against him: and no man can stand it long, who does not get money enough from his business to pay the cash expenses of carrying it on." Finally, character is every thing in respect to credit.

Suspicion of the capability of a person to fulfil his engagements, is hardly less fatal than that of female chastity.

*Advantages of Promptness.* A merchant, whose policy expired at 12 o'clock, called at the insurance office, at half past 11, and obtained a renewal of it. At 2 o'clock the same day, his store and goods were reduced to ashes! This circumstance occurred at the late destructive fire in Augusta, Geo. What would have become of that man's fortune, if he had thought it "would do as well after dinner."

A gentleman in this state, not three years since, was in the practice of renewing his policy, as soon as it had expired; but at length, neglecting it for a few days, his store and valuable contents, were destroyed by fire. From this circumstance we are taught the truth of the old proverb, that "delays are dangerous."

We shall close this chapter with the following Rules, from the private papers of Dr. West, which were according to his memorandum, thrown together as *general way marks* in the journey of life. They were advantageous to him, and while they exhibited an honourable testimony to his moral worth, may be useful to others.

Never to ridicule sacred things, or what others may esteem such, however absurd they appear to me.

Never to resent a supposed injury till I know the views and motives of the author of it. Nor on any occasion to retaliate.

Never to judge a persons character by external appearance.

Always to take the place of an absent person who is censured in company, so far as truth and propriety will allow.

Never to think the worse of another on account of his differing from me in political or religion opinions.

Never to dispute if I can fairly avoid it.

Not to dispute with a man more than seventy years old; nor with a woman; nor with an enthusiast.

Not to effect to be witty, or to jest so as to wound the feelings of another.

To say as little as possible of myself, and those who are near to me.

To aim at cheerfulness without levity.

Not to obtrude my advice unasked.

Never to court the favor of the rich, by flattering either their vanity or their vices.

To respect virtue though clothed in rags.

To speak with calmness and deliberation on all occasions, especially in circumstances which tend to irritate.

Frequently to review my conduct and note my failings.

On all occasions to hope in prospect the end of life and a future state.

Not to flatter myself I can act up to these rules, however honestly I may aim at it.

## CHAPTER XXXV.

### *Sugar, Tea, &c.*

*On the quality of Sugars, with Practical Remarks.* Not having authority, excepting that founded on our own experience, we enter upon the subject laid out for us with some diffidence, as there are many whom we consider our superiors; however, we are willing to abide the test on close investigation.

*Sugars.* Havannas are undoubtedly preferable to any brought to our market, and are not only as profitable to the retailer but most profitable to the consumer. Either white or brown is from ten to fifteen per cent. sweeter; besides the flavour approximates nearer to that of the loaf sugar of the shops: they are imported in boxes, weighing from three to four hundred pounds, free from *foot*, and perfectly dry. Generally every pound, throughout the chest, will correspond with the sample. Chests weighing four hundred pounds, have been known to gain forty pounds; usually twenty-five pounds in the tare. There is a difference in the quality of these sugars, of ten per cent. perhaps more. Some of the Brazils are very fair and profitable. Refiners generally give these sugars a preference.

Of the browns, St. Croix lead in price in some of our markets; they certainly are very superior sugars, very clean, richly grained, and of a lively colour, but wanting in that fine flavour which distinguishes the Havannas.

The Calcutta sugars are mixed advantageously with the ordinary sugars of the islands. These mixtures require some care, or the improvement might be called a deception. Some of these sugars have a very bad flavour, and should be avoided by the purchaser: but those of prime quality are very fair and saleable; they are imported in bags weighing from one to two hundred pounds. There are many other kinds we



should be glad to notice, if our limits would permit, but we can only indulge ourselves in a few brief remarks.

The islands furnish sugars of various qualities, precisely as they do of spirits. We have the best rum from St. Croix, (unless Jamaica may be preferred) so it is with respect to sugars; the difference probably arises in a great measure on account of the sweetness of the cane, and the same inference can be drawn in regard to the flavour of sugars; as will be found in the article on flavouring spirits; though much undoubtedly may be attributed to the manufacturer. Vast quantities of sugars are sent into commerce, *unmerchantable*, or rather before they have *ripened*, or been properly drained. This is almost universally the case with New-Orleans, which on opening appear very bright, but the air soon decomposes it, and if not of sufficient ripeness or age, the retailer of pounds generally finds it a most unprofitable article.

We can draw a very fair conclusion of the ripeness of a piece of goods, particularly when it has lain some time in the warehouse. If we discover molasses issuing from the crevices, between the staves and about the heads, and it is evident much has been deposited on the floor about the cask, then, it is also evident it will fall short of the custom-house weight. In every case the draining head or side should always be well probed indeed every part should be carefully examined, or we shall not be certain of its average quality. Much experience and care are required in selecting sugars: perhaps it may not be unprofitable to examine when purchasing, if the casks may not be overcharged with hoops, thick heads, staves &c. Those casks which contain the largest quantity, usually produce the greatest gain in the tare. The allowances and tares on sugar will be found under their respective heads.

*Of Teas.* Tea is distinguished in name, as it differs in colour, flavour and size of its leaf; though its quality is generally recognized under the title of chop.

It is said the Chinese neither drink it in the manner we do, nor so strong, but use it only as their common drink. It is reckoned among them a singular diluter and purifier of the blood; a great strengthener of the brain and stomach, and promoter of digestion, perspiration, &c. They drink it in great quantities in high fevers, cholics, &c. think it a sure though slow remedy in chronic diseases.

It is perhaps unnecessary to remark, that there are few articles in commerce, more variable in quality than teas; and in regard to which we will only observe, that every cargo generally contains several chops, (qualities,) and that we have frequently seen Young Hyson Tea, varying to 40 per cent; consequently no article should be selected with more care: but our present object is more particularly to allude to the substitution of tares not according to law. We have been furnished with abundant evidence that the practice of reweighing teas, after they have passed through the custom house, is incorrect, and most generally, attended with great loss to the retailer of pounds. We believe that we are perfectly familiar with the arguments adduced in favour of the practice, the futility of which we shall now attempt to show:

1st Government regulates commerce; by its officers the duties on imported goods are secured, and at the time of entry the *actual* or *lawful* tares are determined, on all goods subject to be weighed and marked.

2. That the custom-house marks are the only correct and proper marks, must be obvious from the following reasons, viz. in order to secure the full amount of duties; and notwithstanding the willingness of the importer to have his teas marked less than the boxes or chests contain (which we do not believe,) none will pretend that the custom officers do actually exempt a few pounds, on every box from duties, under existing commercial regulations, and that too, as may be suggested, to favour the importer.

Again, we are not led to understand by the tariff that a duty of 40 cents, (the duty on Young Hyson tea,) shall be secured on the boxes in which tea is imported; but that in consequence of general average, (see note in the table of tares &c. and also, laws &c.) some chests will fall short, while others will exceed the custom-house mark (or black mark, as sometimes called by dealers,) on reweight, unless tares are substituted varying from those estimated according to law; but when teas are entered according to invoice, we should suppose this variation would not occur, nor have we reason to believe it does, particularly when the inspector takes into consideration, the difference of the catty pound, (about 18 oz. avoirdupois) and our weight; for it must be understood that boxes or chests, independant of their contents vary in weight, frequently from 1 to 8 pounds; thus, if one chest weighs 18

another 22 and a third 26, the average weight is twenty-two, and according to the principles of the custom-house, (unless the teas are entered according to invoice) each chest would be marked, exclusive of the average tare, which is deducted; (see form of certificate in abstract of Laws, &c.)

It is said by some that the custom-house tares are a *rough calculation*; but is the *systematic* tare, of 19 lbs. without any allowance for draft, after the box or chest has received an addition weight of hoops to be more appreciated, and this too, on quarter chests, without distinction—and 10 lbs. on catty boxes?

And would it not be surprising to one, unacquainted with mercantile transactions to learn that a dealer had bought a chest of tea, and that in the same market, it would not sell for so many pounds, if thrown into the commission merchants hands, as he was charged? The facts in regard to the sales of teas are, as we learn, some country merchants buy their teas at the black mark, or custom-house mark, others, black teas at the black mark, and green teas, by having one pound added to the black mark; others, with an addition of one pound on both green and black teas—others, by reweight and a deduction of 20 lbs. on qr. chests and 10 lbs. on catty boxes others by reweight, (which by some is said to be *customary*) 19 lbs. on qr. chests without distinction. By this last substitution, in some very few instances the vendee will gain perhaps one or two pounds, but will generally loose from one to 10, most frequently, four and five—but, we will ask, do these deviations occur when teas are sold in lots, by the importer, either at private or auction sale? a merchant in Boston, who has been in the tea trade for more than 30 years, writes—“the trade have always obtained their teas at the black mark, and I have not any knowledge of a deviation in other markets, and indeed, there can be none, unless by stipulation.”

There would be many difficulties unavoidably arising, provided tares are substituted, in every case when sales are effected, varying from those established by law, besides the probability that a substitution would not be as likely to be so correct, unless the goods are emptied from every package in order to prevent a general average, which in regard to teas, is not desirable, if practicable, some of which we conceive to be as follows:

1, Suppose we should re-ship teas to any port withing the ju.

risdiction of the United States, and either on her passage, or at her port of entry, the vessel's papers are demanded by the revenue officer, (for it must be remembered the law is explicit, requiring the supercargo or master, not only to produce the certificate of his clearance, but a certificate of each chest of tea, which on failure, both the vessel and cargo are liable at least to be detained, if not forfeited;) we are already apprised of the difficulties which might arise, if not the probable result, (provided the certificate of her clearance only can be procured,) if it could not be proved the teas had been regularly entered at a custom-house. Is it not reasonable then, that every purchaser of a chest of tea, should be entitled to a certificate?

2 Provided our teas are insured, in case of damage how do we prove the quantity shipped? We answer, if our invoice of shipment is correct, we can prove the quantity by the custom-house books, if in no other way, in case the certificates are lost. And on the other hand, if our invoice show teas of a number, with a quantity which the custom-house books do not recognize, the consequences which follow, might, at least, give rise to much litigation.

All those difficulties are however, obviated, by a demand made for the certificates at the time of the delivery of the goods.

A certificate for each chest is made, signed by the supervisor of the port where it was landed, which corresponds with the custom-house brand on the chest, viz. the number of pounds of tea, time of entry &c.

The number of pounds the chest contains is put on with a pencil brush; though sometimes we have seen printed figures: a careful examination will discover to us this mark, called by dealers the black mark, unless rubbed out, which may sometimes be done through motives which cannot be commended.

From what has been said, it follows, that the substitution of tares varying from those established by law, cannot be practiced with impunity.

Finally, we recommend country dealers to attend cargo sales; the advantages to be derived by attending these sales are unnecessary to demonstrate any further than that others can become possessed of every desirable information respecting tares, but also the qualities and standard prices, of almost every staple article.

pounds?

*Of Cotton.* This article is susceptible of being charged with a considerable per centum of moisture, which without close examination is not easily detected. It seems that there should be a general test for detecting impositions of this kind, but we are unable to point it out at the present moment.

We should be glad to extend our remarks to various articles in merchandise, which require much sagacity in purchasing, besides those mentioned above. But we trust enough has already been said to draw the conclusion, that for the sake of money, many overleap the bounds of right, and it should seem, subject themselves to the loss of respect and confidence, notwithstanding they may evade the laws of the country.

#### SOLID MEASURE OF SQUARE TIMBER.

By the following table the solid contents, and the value of any piece or quantity of timber, stone, &c. may be found at sight, from six to twenty-five and a half inches, the side of the square, or one fourth of the girth, from fourteen to eighty feet in length. It rises from six, half an inch at a time, to twenty-five and a half inches, and from fourteen, one foot at a time, till it rises to eighty.

The number of inches which the side of each stick measures, are placed at the top commencing next to the left hand column on the first of each page. These columns give the contents of each stick, and the first column of each page which runs from the top to the bottom, the length. Half feet are not reckoned; that is, when a stick measures thirty cubic

feet and five inches, it is called only thirty feet; if thirty feet and 7 inches, it is reckoned 31 feet. We believe this method is practised in all the cities in the United States and Canada.

feet in	side 6	side 6 1-2	side 7	side 7 1-2	side 8	side 8 1-2	side 9	side 9 1-2	side 10	side 10 1-2	side 11	side 11 1-2	side 12	side 12 1-2
length.	in.	inch	inch	inch	inch	inch	inch	inch	inch	inch	inch	inch	inch	in.
14	3	4	5	5	6	7	8	9	9	10	12	13	14	15
15	4	4	5	6	6	7	8	9	10	11	12	14	15	16
16	4	5	5	6	7	8	9	10	11	12	13	14	16	17
17	4	5	6	6	7	8	9	10	12	13	14	15	17	18
18	4	5	6	7	8	9	10	11	13	14	15	16	18	19
19	5	6	6	7	8	9	10	12	14	14	16	17	19	21
20	5	6	7	8	9	10	11	12	14	15	17	18	20	22
21	5	6	7	8	9	10	12	13	15	16	17	19	21	23
22	5	6	7	8	10	11	12	14	16	17	18	20	22	24
23	6	7	8	9	10	11	13	14	16	17	19	21	23	25
24	6	7	8	9	10	12	13	15	17	18	20	22	24	26
25	6	7	8	10	11	12	14	15	17	19	21	23	25	27
26	6	8	9	10	11	13	14	16	18	20	22	24	26	28
27	7	8	9	10	12	13	15	17	19	20	22	25	27	29
28	7	8	9	11	12	14	16	18	20	21	23	25	28	30
29	7	9	10	11	13	14	16	18	20	22	24	26	29	31
30	7	9	10	12	13	15	17	19	21	23	25	27	30	33
31	8	9	10	12	14	15	17	19	21	23	26	28	31	34
32	8	9	11	12	14	16	18	20	22	24	27	29	32	35
33	8	10	11	13	14	16	18	20	23	25	27	30	33	36
34	8	10	11	13	15	17	19	21	24	26	28	31	34	37
35	9	10	12	13	15	17	19	22	24	27	29	32	35	38
36	9	11	12	14	16	18	20	23	25	27	30	33	36	39
37	9	11	12	14	16	18	21	23	26	28	31	34	37	40
38	9	11	13	15	17	19	21	24	27	29	32	35	38	41
39	10	11	13	15	17	19	22	24	27	30	33	36	39	42
40	10	12	13	15	18	20	22	25	28	30	33	36	40	43
41	10	12	14	16	18	21	23	25	29	31	34	37	41	44
42	10	12	14	16	18	21	23	26	29	32	35	38	42	45
43	11	13	14	17	19	21	24	27	30	33	36	39	43	46
44	11	13	15	17	19	22	25	27	30	34	37	40	44	48
45	11	13	15	17	20	22	25	28	31	35	38	41	45	49
46	11	13	15	18	20	23	26	29	32	35	38	42	46	50
47	12	14	16	18	21	23	26	29	33	36	39	43	47	51
48	12	14	16	19	21	24	27	30	33	37	40	44	48	52
49	12	14	16	19	22	24	27	30	34	38	41	45	49	53
50	12	15	17	19	22	25	28	31	34	38	42	46	50	54

Ft. in length.	side 6 in.		side 6 1-2 in.		side 7 in.		side 7 1-2 in.		side 8 in.		side 8 1-2 in.		side 9 in.		side 9 1-2 in.		side 10 in.		side 10 1-2 in.		side 11 1-2		side 11 in.		side 12 in.		side 12 1-2 in.	
51	13	15	17	20	22	25	28	32	35	39	43	47	51	55														
52	13	15	17	20	23	26	29	32	36	40	43	48	52	56														
53	13	16	18	20	23	26	30	33	37	41	44	49	53	57														
54	13	16	18	21	24	27	31	34	37	42	45	50	54	58														
55	14	16	18	21	24	27	31	34	38	42	46	51	55	59														
56	14	16	19	22	25	28	32	35	39	43	47	52	56	60														
57	14	17	19	22	25	28	32	36	39	44	48	53	57	62														
58	14	17	19	22	26	29	33	36	40	44	49	54	58	63														
59	15	17	20	23	26	29	33	37	41	45	49	55	59	64														
60	15	18	20	23	26	30	34	37	41	46	50	56	60	65														
61	15	18	20	24	27	30	34	38	42	47	51	56	61	66														
62	15	18	21	24	27	31	35	39	43	47	52	58	62	67														
63	16	18	21	24	28	31	35	39	44	48	53	59	63	68														
64	16	19	21	25	28	32	36	40	44	49	54	59	64	69														
65	16	19	22	25	29	32	36	41	45	50	54	60	65	71														
66	16	19	22	26	29	33	37	41	46	51	55	61	66	72														
67	17	20	22	26	30	33	37	42	46	52	56	62	67	73														
68	17	20	23	26	30	34	38	42	47	52	57	62	68	74														
69	17	20	23	27	30	34	39	43	48	53	58	63	69	75														
70	17	21	23	27	31	35	39	44	48	54	59	64	70	76														
71	18	21	24	27	31	35	40	44	49	54	59	65	71	77														
72	18	21	24	28	32	36	40	45	50	55	60	66	72	78														
73	18	21	25	28	32	36	41	46	50	56	61	67	73	79														
74	18	22	25	29	33	37	41	46	51	57	62	68	74	80														
75	19	22	25	29	33	37	42	47	52	57	63	69	75	81														
76	19	22	26	29	34	38	43	47	53	58	64	70	76	82														
77	19	23	26	30	34	38	44	48	53	59	64	71	77	83														
78	19	23	26	30	34	39	44	49	54	59	65	71	78	84														
79	20	23	27	31	35	39	45	49	55	60	66	72	79	86														
80	20	23	27	31	35	40	45	50	55	61	67	73	80	87														



Ft. in lengths.	side 13 inches	side 13 1-2 in.	side 14 n.	side 14 1-2 in.	side 15 n.	side 15 1-2 in.	side 16 n.	side 16 1-2 in.	side 17 in.	side 17 1-2 in.	side 18 in.	side 18 1-2 in.	side 19 in.	side 19 1-2 in.
14	16	17	19	20	22	23	25	26	28	30	31	33	35	37
15	17	19	20	22	23	25	26	28	30	32	34	35	37	39
16	19	20	22	23	25	26	28	30	32	34	36	38	40	42
17	20	21	23	25	26	28	30	32	34	36	38	40	42	45
18	21	23	24	26	28	30	32	34	36	38	40	43	45	47
19	22	24	26	27	29	31	34	36	38	40	43	45	47	50
20	23	25	27	29	31	33	35	38	40	42	45	47	50	53
21	25	26	28	30	33	35	37	39	42	44	47	50	52	55
22	26	28	30	32	34	36	39	41	44	47	49	52	55	58
23	27	29	31	33	36	38	41	43	46	49	52	54	57	60
24	28	30	32	35	37	40	42	45	48	51	54	57	60	63
25	29	31	34	36	39	41	44	47	50	53	56	59	62	65
26	30	33	35	38	40	43	46	49	52	55	58	62	65	68
27	32	34	37	39	42	45	48	51	54	57	61	64	67	70
28	33	35	38	41	44	46	50	53	56	60	63	66	70	74
29	34	36	39	42	45	48	51	55	58	62	65	69	72	76
30	35	38	41	44	47	50	53	56	60	64	67	71	75	79
31	36	39	42	45	48	51	55	58	62	66	70	73	77	82
32	38	40	43	46	50	53	57	60	64	68	72	76	80	84
33	39	42	45	48	51	55	58	62	66	70	74	78	82	87
34	40	43	46	49	53	56	60	64	68	72	76	81	85	90
35	41	44	47	51	54	58	62	66	70	74	79	83	87	92
36	42	45	49	52	56	60	64	68	72	77	81	85	90	95
37	43	47	50	54	58	61	66	70	74	78	83	88	93	97
38	44	48	51	55	59	63	67	72	76	81	85	90	95	100
39	46	49	53	57	61	65	69	73	78	83	88	92	98	103
40	47	50	54	58	62	66	71	75	80	85	90	95	100	105
41	48	52	55	60	64	68	73	77	82	87	92	97	103	108
42	49	53	57	61	65	70	74	79	84	89	94	100	105	111
43	50	54	58	63	67	71	76	81	86	91	97	102	108	113
44	51	55	60	64	69	73	78	83	88	93	99	104	110	116
45	53	57	61	65	70	75	80	85	90	95	101	107	113	119
46	54	58	62	67	72	76	82	87	92	98	103	109	115	121
47	55	59	64	68	73	78	83	89	94	100	106	111	118	124
48	56	60	65	70	75	80	87	91	96	102	108	114	120	127
49	57	62	66	71	76	82	87	92	98	104	110	116	123	129
50	58	63	68	73	78	83	89	94	100	106	112	119	125	132

Ft. in length.	side 20 in.	side 20 1-2 in.	side 21 in.	side 21 1-2 in.	side 22 in.	side 22 1-2 in.	side 23 in.	side 23 1-2 in.	side 24 in.	side 24 1-2 in.	side 25 in.	side 25 1-2 in.
14	39	41	43	45	47	49	51	53	56	58	61	63
15	41	44	46	48	50	52	55	57	60	62	65	67
16	44	46	49	51	54	56	59	61	64	66	69	72
17	47	49	52	54	57	60	62	65	68	71	74	77
18	50	52	55	58	60	63	66	69	72	75	78	81
19	53	55	58	61	64	67	70	73	76	79	82	86
20	55	58	61	64	67	70	73	76	80	83	87	90
21	58	61	64	67	70	74	77	80	84	87	91	95
22	61	64	67	70	74	77	81	84	88	91	95	99
23	64	67	70	74	77	81	84	88	92	96	100	104
24	66	70	73	77	80	84	88	92	96	100	104	108
25	69	73	76	80	84	88	92	96	100	104	108	113
26	72	76	79	83	87	91	95	99	104	108	113	117
27	75	79	82	86	91	95	99	103	108	112	117	122
28	78	81	86	90	94	98	103	107	112	116	121	126
29	80	84	89	93	97	102	106	111	116	121	126	131
30	83	87	92	96	101	105	110	115	120	125	130	135
31	86	90	95	99	104	109	114	119	124	129	134	140
32	89	93	98	102	107	112	117	122	128	133	139	144
33	91	96	100	106	111	116	121	126	132	137	143	149
34	94	99	104	109	114	119	125	130	136	141	147	153
35	97	102	107	112	117	123	128	134	140	146	152	158
36	100	105	110	115	121	126	132	138	144	150	156	162
37	103	108	113	119	124	130	136	142	148	154	160	167
38	105	111	116	122	127	133	139	145	152	158	165	171
39	108	114	119	125	131	137	143	149	156	162	169	176
40	111	116	122	128	134	140	147	153	160	166	173	180
41	114	119	125	131	137	144	150	157	164	171	178	185
42	116	122	128	135	141	147	154	161	168	175	182	189
43	119	125	131	138	144	151	158	165	172	179	186	194
44	122	128	135	141	148	154	161	168	176	183	191	198
45	125	131	138	144	151	158	165	172	180	187	195	203
46	128	134	141	147	154	161	169	176	184	192	199	207
47	130	137	144	150	158	165	172	180	188	196	204	212
48	133	140	147	154	161	169	176	184	192	200	208	217
49	136	143	150	157	164	172	180	188	196	204	212	221
50	139	146	153	160	168	176	183	192	200	208	217	226

Ft. in length.	side 13 in.	side 13 1-2 in.	side 14 in.	side 14 1-2 in.	side 15 in.	side 15 1-2 in.	side 16 in.	side 16 1-2 in.	side 17 in.	side 17 1-2 in.	side 18 in.	side 18 1-2 in.	side 19 in.	side 19 1-2 in.
51	60	64	69	74	79	85	90	96	102	108	115	121	128	134
52	61	66	71	76	81	87	92	98	104	110	117	123	130	137
53	62	67	72	77	82	88	94	100	106	112	119	126	133	140
54	63	68	73	79	84	90	96	102	108	115	121	128	135	142
55	64	69	75	80	86	92	98	104	110	117	124	130	138	145
56	66	71	76	82	87	93	99	106	112	119	126	133	140	148
57	67	72	77	83	89	95	101	108	114	121	128	136	143	150
58	68	73	79	84	90	97	103	109	116	123	130	138	145	153
59	69	74	80	86	92	98	105	111	118	125	133	140	148	156
60	70	76	81	87	94	100	106	113	120	127	135	142	150	158
61	71	77	83	89	95	102	108	115	122	129	137	145	152	161
62	73	78	84	90	97	103	110	117	124	132	139	147	155	163
63	74	79	86	92	98	105	112	119	126	135	142	150	158	166
64	75	81	87	93	100	106	114	121	128	136	144	152	160	169
65	76	82	88	95	101	108	115	123	130	138	146	154	163	171
66	77	83	90	96	103	110	117	125	132	140	148	157	165	174
67	78	85	91	98	105	112	119	126	134	142	151	159	168	177
68	80	86	92	99	106	113	121	128	136	144	153	161	170	179
69	81	87	94	101	108	115	122	130	138	146	155	164	173	182
70	82	88	95	102	109	117	124	132	140	149	157	166	175	185

*This table is extended to sixty instead of eighty feet in length, as first mentioned—a further continuation is thought unnecessary.*

Continued from page 292.

51	141	149	156	163	171	179	187	196	204	212	221	230
52	144	152	159	167	175	183	191	199	208	217	225	235
53	147	154	162	170	178	186	194	203	212	221	230	239
54	150	157	165	173	181	190	198	207	216	225	234	244
55	153	160	168	176	185	193	202	211	220	229	239	248
56	155	163	171	180	188	197	205	215	224	233	243	253
57	158	166	174	183	191	200	209	219	228	237	247	257
58	161	169	177	186	192	204	213	222	232	242	252	262
59	164	172	180	189	198	207	217	226	236	246	256	266
60	166	175	184	192	202	211	220	230	240	250	260	271

## CHAPTER XXXVIII.

## GUNTER'S RULE.

This Rule, the invention of Edward Gunter, though in common use, still there are not many who have a perfect acquaintance with it. It is, indeed, a ready reckoner, as the following illustrations will exemplify. It requires but little practice to render the rule familiar and easy; and truly, we recommend it as a useful study, particularly to those who are engaged in the mechanic arts. It is confidently believed none among the few who have been taught this rule, have regretted the time which has been devoted for the purpose.

*Of the Lines.* The first Line, marked S R corresponds to the Logarithms of natural Sines of every point of the mariners compass and is numbered from the left hand onward to the right from 1 to 8 inclusive where a brass pin is fixed; this line can be divided into halves and quarters.

*The second line* T R corresponds to the Logarithms of the tangents of every point of the compass and is numbered at the right hand 1. 2. 3. 4. where a brass pin is fixed; thence, towards the left hand with 5. 6. 7. This line is divided into halves and quarters, like the preceding.

*The third line* N U M corresponds to the Logarithms of numbers, beginning at the left hand with 1; thence onward to the right hand are 2 to 9 inclusive; and in the middle, 1; at which point a brass pin is fixed; then 2. 3. 4. 5. 6. 7. 8. 9. and 10. at the end, where there is another pin. These numbers and the intermediate divisions, depends on the estimated values of the extreme numbers, 1 and 10. This line is undoubtedly the most important, and therefore, requires a more particular illustration.

*Illustration 1.* The first one may be considered 1. 10. 100. or 1000:—2 in the same manner, 20, 200, &c.

2. The first 1, may be called one tenth, one hundredth, one thousandth part, &c.; and 2. two tenths or two hundredths, &c.

3. Now if the first 1 is called 1, the middle 1 is computed 10; and 2 at its right hand 20, 3 is 30 and 10 at the end 100; the next 2 is 20, 3 is 30 &c. making the middle 1, 100; the next 2, 200; 3, 300 and 10 at the end 1000.

4. If the first 1 is estimated, one tenth part, the next 2 is two tenth parts, and the middle 1 is one, and the next 2 is two, and 10 at the end is ten.

5. If the first 1 is counted one hundredth part, the next 2 is two hundredth parts; the middle 1 is ten hundredth parts; the next two hundredth part, in which case the middle 1 is called ten hundredth part, or one tenth part, and the next 2 two tenth parts; and 10 at the end is counted 1.

6. As the figures increase or diminish in value, thus likewise, must the intermediate strokes or subdivisions; that is, if the first 1 at the left hand is counted 1, then 2 next following is 2 and each subdivision between them is one tenth part, and in like manner to the middle 1, which in this case is 10, the next is 20; then observe, the longer strokes between 1 and 2 must be counted from the centre 1, eleven, twelve, where there is a brass pin; then 13. 14. 15, sometimes a longer stroke than the rest; then, 16. 17. 18. 19. 20, at the figure 2; and the same method is to be adopted in regard to the short strokes, between the figures 2 and 3 and 4 and 5 &c. which are to be counted as unites.

7. If one at the left hand is 10, the figures between it and the middle 1 are common tens; the subdivisions between each figure, unites: from the middle 1 to 10 at the end, each figure is hundredths; and between these figures each longer division is ten. By attending to these directions it will be easy to find the divisions representing a given number.

*Example 1.* Suppose the point representing the number 12 is required—take the division at the figure 1 in the middle for the first figure of 12; and for the second figure, count two tenths on longer strokes to the right hand, and the last is the point representing 12 where the brass pin is fixed.

2. Suppose the number 22 is required; the first figure begins 2. 1—take the division to the figure 2 and for the second figure count two tenths onward, which is the point representing 22.

3. Suppose 1728 is required—take the middle 1 for the first figure 1; for 7 count onward as before which is 1700; and as the remaining figures are 28 or nearly 30, note the point which is 8-10 nearly, for the distance between the marks 7 & 8, the point representing 1728.

4. When the point which represents 435 is required, from the 4 in the second interval count towards 5 on the right; three of the larger, and one of the smaller divisions, the smaller being half way between the marks 3 and 4, which is the division denoting 435; and thus with other numbers, which is easily effected with a little practice.

The frations found in this line must be called decimals, or if otherwise, they are not, must be reduced to decimals which is readily done by extending the compasses from the denominator, to the numerator, the extent of which, if laid in the same way from 1 in the middle or right hand, will reach to the decimal required.

*Example.* The decimal fraction equal to  $\frac{3}{4}$  is required; extend from 4 to 3, which extent will reach from 1 on the middle to 75 towards the left hand; thus, in like manner of any other vulgar fraction.

The method of performing Multiplication on this line, is by extending from 1 to the multiplier, the extent of which will reach from the multiplicand to the product.

*Example.* Find the product of 16 multiplied by 4; extend from 1 to 4; the extent will reach from 16 to 64 the required product.

For Division extend from the divisor to unity; the extent will reach from the dividend to the quotient.

*Example.* Required to divide 64 by 4; extend from 4 to 1 which extent will reach from 64 to 16 the quotient.

By the Rule of Three, questions are solved on this line.

*Example.* Extend from the first to the second line, which extent will reach from the third to the fourth or answer.

It should be noticed that by extending to the left from the first number or term to the second, you must also extend to the left from the third to the fourth, and thus contrawise.

*Example.* If 7 inches are the diameter of a circle, and 22 in circumference, what is the circumference of another circle 14 inches in diameter? Extend from 7 to 22, which extent will reach from 14 to 44 the same way.

The superficial contents of any Parallelogram is found by extending from 1 to the breadth; which extent will reach from the length to the superficial contents.

*Example.* Suppose a board 15 inches in width and 27 feet long. extend from 1 to 1 foot 3 inches, or 1,25, which extent will reach from 27 feet to 33,75, the superficial contents.

The solid contents of a Bale or Box is found by extending from 1 to the breadth, which extent will reach from the depth to a fourth number; and the extent from 1 to that fourth number, will reach from the length to the solid contents.

*Example 1.* The solid contents of a square pillar is required, length, 21 ft. 9 in. breadth 1 foot 3 inches.

The extent from 1 to 1,25 reaches from 1,25 the depth, to 1,56 the contents of one foot in length.

2d. The extent from 1 to 1,56, reaches from the length 21,75, to 33,9 or nearly 34, the solid contents in feet.

3. To find the solid contents of a piece of timber 1,25 feet wide, and 0,56 feet deep. and 36 feet long.

Extend from 1 to 7, which extent will reach from 36 to 25,2, the solid contents.

The tonnage of bales may be ascertained by this method, by being divided by 50, gives the answer.

#### A TABLE OF BOARD MEASURE

Extending from 4 to 100 feet in length and 36 inches in width.

*Illustration.*—Draw out the slide to the place where 36 coincides with 12 on the fixed part :—count the first 1 on the fixed part 10 ; begin at 4, on the fixed part 4, so on to 10 at the center, and thus to 100 on the right hand to A—begin on the slide at 4 and reckon at different lengths—

Fixed part	4	5	6	7	8	10	12	15	20	25	30	33	40	50	55	60	66	70	75	80	90	100
Slide,	12	15	18	21	24	30	36	45	60	75	90	100	120	150	165	180	200	210	225	240	270	300

#### Miscellaneous Examples.

1. There are 42 feet in a board 14 feet long, 36 inches wide ; how many feet in 27 boards of the same dimensions ? draw the slide to the place where 27 coincides with the centre 1 ; opposite 42 on the fixed part is the answer 1134, on the slide.

2. A log 12 feet long, 24 inches in diameter, cuts 15 boards, 20 inches broad—draw out the slide to the place where 20 will be opposite 12—20 is the answer for one board—draw out the slide till 15 comes against the center 1 on the fixed part, and against 20 on the fixed part is 300, the answer in board measure, on the slide.

3. A log 2 feet in diameter and under—2 inches on each side allowed for slab, 1-5 for sawcalf, 1 board for wane—from 24 to 36 inches in diameter, 3 inches for the slab, 1-5 for sawcalf, and two boards for wane.

4. A log 28 inches at the small end, will cut 18 boards, only 16 measured—draw out the slide till 22, the breadth of the board comes against 12—and against 14, the length on the fixed part, is the answer 25 3-4 for one board on the slide ; now draw out the slide till 16, the number of boards, come

against the center I: to find the residue, say the log is 14 feet long, the answer on the slide is 414 feet.

5. A log 14 feet long, 36 inches at the small end slaved, leaves the board 30 inches wide; 1-5 for sawcalf, leaves 24 and 2 wane leaves 22—draw out the slide till 30 comes against 12 on the fixed part, and under 14 on the fixed part, is found 35 on the slide; then draw out the slide till 22 comes against the center I; and against 35 will be found 770 on the slide, which is the answer for a log 36 inches in diameter and 14 feet long.

6. A log 20 inches at the small end, and 16 feet long cuts 13 boards which are 16 inches wide, and only 12 measured—how many feet—answer—255.

7. A log 16 inches in diameter 14 feet long cuts nine boards, and only 8 measured; makes 112 feet on the slide.

*Method of measuring Square timber in solid feet.*

*Illustration.* Draw out the slide to the left hand, till the length of the timber found on the slide coincides with 12 on the girt line—then opposite the inches, the stick is square on the girt line, and the number of cubic feet on the slide is found.

*Example.* To measure a stick of timber 60 feet long and from 5 to 40 inches square—draw the slide to the left hand, till 6 on the slide calling it 60; coincides with 12 on the girt line, and against 5 on the slide, is 1042-100th on the girt line. the same answer is found by drawing the slide to the right, but the divisions are not so easily distinguished without much practice.

By letting the slide remain all the questions proposed above may be solved in a short time; the answers are as follows, computing the timber at 60 feet in length.



Inches.	Cubic feet.	Inches.	Cubic feet.	Inches.	Cubic feet.
square.	in the stick.	square.	in the stick.	square.	in the stick.
5	10.42	13	70 1-2	23.	220
6	15.	14	82	23 1-2.	231 3-4
7	20.42	14 1-2	88	24.	242
7 1-2	23 1-3	15	94	24 1-2	250
8	26 2-3	15 1-2	100 1-2	25.	260
8 1-2	30 1-10	16	106 1-2	26.	282 1-2
9	33 1-2	17	120 1-3	27.	303
9 1-2	37 2-3	18	135	28.	327
10	41 2-3	18 1-2	142	29.	352
10 1-2	46	19	150	30.	375
11	50.42	19 1-2	158	31.	402
11 1-2	55	20	166 2-3	32.	426
12	60	20 1-2	174 2-3	35.	510
12 1-2	65 1-5	20 3-4.	180	38.	602
		21	184 2-3	40.	667
		22	202		

*To measure Hewn Timber that is not square.*

*Example. I.* The solid feet in a stick of timber, 50 feet in length, and 7 by 10 inches—is required—draw out the slide till 50 coincides with I2 on the the girt line, and against the thickness 7 inches found on the girt line, 17 is found on the slide, which is the answer at 7 inches square—3 times 7—21 inches will remain, and 50 feet long yet to find, which to obtain draw the slide to the right, till 21 on the slide coincides with I2 on the line marked A; then against 50, the length found on A, is 87 1-2 on the slide—this must be divided by I2 and and it will give 7 feet 3 1-2 inches or 7 1-4 which being added to the 17, gives 24 1-4 feet, the contents of the stick.

2 To find the solid feet in a stick 45 feet long 27 inches wide, 22 inches thick—draw out the slide till 45 on the slide coincides with I2 on the girt line; then over 22 found on the girt line will be 151 1-2 on the slide, which gives the dimensions of a stick 45 feet long and 22 inches square—now 5X 22, remain=110, which find on the slide, and let it coincide with I2 on A; then opposite 45 on A is 413 on the slide, which being divided by I2 gives 34 1-3 added to 151 1-2 gives nearly 186 for the answer.

5 To find the solid feet in a stick of timber 60 feet long 30 inches wide and 14 inches thick—draw out the slide till 60 on the slide, coincides with I2 on the girt line, then over

14 on the girt line is 81 2-3 on the slide; by doubling this it gives the contents, equal to 28 by 14 and the 2 left is 2 by 14, which is 1-7 of 14, divide  $81\ 2-3 = 11\ 2-3$ —then add  $81\ 2-3$ ,  $81\ 2-3$ ,  $11\ 2-3 = 175$  the answer—or find the average square  $= 20,5$ . Then find 20,5 on the girt line, and directly over it on the slide is 175; observing to draw out the slide till the length of the stick in feet coincides with 12 on the girt line.

4 To find the solid feet of a stick of timber, 55 feet long 25 inches wide and 20 thick.

Draw out the slide till 55 coincides with 12 as before, then over 20 on the girt line is nearly 153—which being divided by 4 and the quotient added, 191 1-3 feet is the answer. Or for the 5 inches left say 5 times 20 is 100—the square root of which is 10; now look on the slide over 10—38 1-3 is found as before—Or cast it into a square—as 9 by 4 multiplied gives 36—the square root of which is 6 the answer—or cast the log into board measure, by drawing the slide against 30 the width, on the slide under 12 on the fixed part A—then under 60, the length on the fixed part, is 150 on the slide, the number of square feet in one board—then lay 14, the width on the slide, under 1 on the fixed part, then against 150 on the fixed part, which gives 2100 feet boards on the slide—now divide by 12 by drawing 1 on the slide, against 12 on the fixed part, then against 2100 on the fixed part will be found 175 on the slide, the answer in cubic feet.

#### *Method of Gauging round timber.*

*Illustration.* Let the gauge point, on the girt line be 13,54 inches—to find the contents of a stick, bring the length of the timber found on the slide to coincide with the gauge point—then the diameter in inches or parts, found on the girt line, will coincide with the number of cubic feet on the slide.

*Ex.* Suppose a stick 12 feet long and 15 inches in diameter—how many cubic feet against 15 inches is 15 feet and in like manner against 20, 26 1-2—30, 59—35, 80, 8 feet.

Some rules are incorrect, but the following trial will prove them. Pass the slide to the right hand till 1 on the slide coincides with 2 on the fixed part, when 2 on the slide should coincide with 4 on the fixed part, continue to draw the slide till 1 coincides with 3 on the fixed part then 2 on the slide should coincide with 6 on the fixed part, till 1 on the slide coincides with 4 on the fixed part then 2 on the slide should coincide with 3 on the fixed part—till 1 coincides with 5, then 2 will coincide with the center 1—till 1 coincides with 5 1-2—then 2 will coincide with 11—till 1 coincides with 6—then 2 will coincide with 12, and continue to do the same till you have gone through the line, and if the rule is correctly graduated, the result will be as above stated.

The line marked SIN, corresponds to the Logarithmick sines of the degrees of the quadrant, and begins at the left hand, and is numbered onward to the right, thus, 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. then 20. 30. &c. ending at  $90^\circ$  at a brass centre pin, similar as at the right hand of the lines.

The line marked V S corresponds to the Log. Versed Sines of the degrees of the quadrant, and begins at the right hand opposite  $90^\circ$  on the sine; and numbered onward to the left, thus, 10. 20. 30. &c. ending at the left hand, at about  $169^\circ$ . Each of the subdivisions from 10 to 30 is, generally, two degrees—from thence to 90, are single degrees, thence to the end, each degree is divided into 15 minutes.

The line marked TANG corresponds to the Log. Tangents of the degrees of the quadrant and begins at the left hand, and is numbered towards the right, thus, 1. 2. 3. 4. 5. to 10. 20. 30. 40. and 45. at a fixed brass pin under  $90^\circ$  on the sines—from thence, it is numbered backwards 50. 60. 70. 80. to 89 ending at the left hand where it begins at one degree. The subdivisions are much like those of the sines.

If you have an extent in your dividers to be set off from any number less than 45 deg. on the line of tangents towards the right, and is found to reach beyond the mark 45 deg. observe how far it extends beyond that mark, and set it off towards the left, and mark the degree it falls upon, the number sought, which must exceed 45 deg. On the contrary, if you are to set off a distance to the right, from a number greater than 45 deg. you must proceed as before, remembering that the answer will be less than 45 deg. and considering the degrees always more than 45 deg. precisely as if they were marked on the continuation of the line to the right hand of 45 deg.

The line marked MER, (meridional parts) begin at the right hand; is numbered 10. 20. 30 to the left hand, ending at 87 deg. which with the line marked E P (equal parts) are used together, only in Mercator's sailing. The upper line shows the degrees of the meridian, or latitude, in Mercators chart, which corresponds to the degrees of longitude on the lower line.

*Grindstones*, are usually sold at the quarries by the stone which is computed at 24 inches diameter and 4 thick. Rule, multiply the square of the diameter, in inches, by the thickness, in inches, and divide the product by 2304 which gives the answer.

To find the number of stone in one of 36 in. diameter and 8 in. thick; 36 by 36—1296 square, by 8, 10368, which divided by 2304—4 1-2 ans.

*By the Gunters rule*, by means of the line of numbers. Extend from 48 to the diameter; continue that extent three times its length from the thickness and it will reach to the number of stones required; so in the foregoing example, extend from 48 to 36 the diameter; continue that extent three times its length from the thickness which is 8 inches, and it will reach to 4. 5. or 4  $\frac{1}{2}$  the answer.

There is a line marked ML on the Gunters rule which is joined to a line of cords and shows how many miles of eastings and westings corresponds to a degree of longitude in every degree of latitude; and as this is found also on most of the plain scales, it is not deemed necessary to explain its uses, or the common problems of nautical astronomy particularly as they are more accurate to perform by Logarithms.

#### OF THE SLIDING RULE.

This Rule is of the same dimensions of the common Gunter's Rule. The fixed part, has similar lines, which is used with dividers in the same manner, as has been described, it being sufficient to observe there are two lines of numbers, viz. a line of Logarithmick sines, and a line of logarithmick tangents on the slide.

The slide is designed to be shifted so as to fix either face of it on either side of the fixed part of the rule, as the nature of the question required to be solved may be, which if questions in arithmetic, trigonometry, &c. let the proportion be so stated, that the first and third terms are alike, and of course the second and fourth terms will agree—then bring the first term of the analogy on the fixed part opposite the second term on the slide, or, the first and third term may be found on the slide, and the second and fourth on the fixed part.

In multiplication and division, unity should be considered as one of the terms of analogy.

*Multiplicaton.*—By multiplication, set 1 on the line of numbers of the fixed part opposite one of the factors on the line of numbers on the slide—then against the other factor on the fixed part will be found the product on the slide.

#### *Miscellaneous Examples.*

To find the product of 5 by 12—draw the slide out till 1 on the fixed part coincides with 5 on the slide—then opposite 12 on the fixed part will be found 60—the product on the slide.

The product of 50 by 12 required—not moving the slide,

count 5 to be 50—count 12 as before—then opposite 12 on the fixed part will be found 600 on the slide.

Place the slide as before; estimate 5 for 500 and 12 at 1200, and the slide gives 600,000 for the answer.

The product of 17 by 25—draw out the slide till 1 on the fixed part coincides with 17 on the slide—then opposite 25 on the fixed part is found 425 on the slide.

17 by 17—draw out the slide till 1 on the fixed part coincides with 17 on the slide—then opposite 17 on the fixed part is 289 on the slide.

Place the slide as before—opposite 50 on the fixed part will be found 850 on the slide.

The slide laying at 17 as before, reckon 50 or 5 to be opposite 500 on the fixed part, and 8500 is found on the slide.

Place the slide as before, count 17 to be 1700, count 3 to be 300 on the fixed part; then, opposite 300 on the fixed part will be found 510,000 on the slide.

21 1-2 by 20—draw out the slide till the center 1 on the fixed part coincides with 21 1-2 on the slide—then opposite 20 on the fixed part will be found 430 on the slide

5 by 2 1-2—reckon the first 1 on the fixed part to be 1-10—the center 1 count 1—draw out the slide till 1 on the fixed part coincides with 5 on the slide—opposite 2 1-2 on the fixed part will be found 12 1-2 on the slide.

### *Division.*

*Illustration.*—Place the divisor on the line of numbers of the fixed part opposite 1 on the slide, then against the dividend found on the fixed part, will be found the quotient on the slide.

*Ex. 1.* Required to divide 60 by 5. Set 5 on the fixed part against 1 on the slide; then against 60 on the fixed part is 12 = the quotient on the slide.

*Ex. 2.* 400 by 27—set 27 on the fixed part opposite 1 on the slide; then against 400 on the fixed part will be found 14 22-27 or about 14 4-5 on the slide.

Not moving the slide, and placed as in example 2, we have the following result, having gone the length of the fixed part to A, on the statement:—

Divisors 27—dividend 400=quotient 14 4-5 or 22-27:-500 = 18 1-2 or 18 14-27:-600=22 2-9 or 22 1-4:-700=25 25-27 or 26 nearly:-800=29 17-27 or 29 2-3:-850=31 13-27 or 31 1-2:-900=33 1-3:-1000=37 1-27 or 37,

To divide any number from 700 to 6000, that is, at B on

the slide, the full extent of the slide. From the statement draw out the slide on A, to the left hand of the centre 1, to the figure 6, representing 60 on the fixed part, over 1 on the slide, then against 7 representing 700 on the fixed part, will be found 11 2-3 on the slide; not moving the slide we will find the following answers:—

Divisors called 60—Dividend 700. quotient, 11 2-3:—800 = 13 2-3:—900 = 15:—1000 = 16 2-3:—1100 = 18 1-3:—1200 = 20:—1300 = 21 2-3:—1400 = 23 1-3:—1500 = 25:—1600 = 26 2-3:—1700 = 28 1-3:—1800 = 30:—1900 = 31 2-3:—2000 = 33 1-3:—2100 = 35:—2200 = 36 2-3:—2300 = 38 1-3:—2400 = 40:—2500 = 41 2-3:—2600 = 43 1-3:—2700 = 45:—2800 = 46 2-3:—2900 = 48 1-3:—3000 = 50:—3100 = 51 2-3:—3200 = 53 1-3:—3300 = 55:—3400 = 56 2-3:—3500 = 58 1-3:—3600 = 60:—3700 = 61 2-3:—3800 = 63 1-3:—3900 = 65:—4000 = 66 2-3:—4100 = 68 1-3:—4200 = 70:—4300 = 71 2-3:—4400 = 73 1-3:—4500 = 75:—4600 = 76 2-3:—4700 = 78 1-3:—4800 = 80:—4900 = 81 2-3:—5000 = 83 1-3:—5100 = 85:—5200 = 86 2-3:—5300 = 88 1-3:—5400 = 90:—5500 = 91 2-3:—5600 = 93 1-3:—5700 = 95:—5800 = 96 2-3:—5900 = 98 1-3:—6000 = 100. Ending at B on the right hand of the slide.

*By the Rule of Three.*

*Miscellaneous Examples.* If 3 lbs. beef cost 21 cts, what will from 30 to 100 lbs. ?—bring 3 on the letter A, of the fixed part, on the line of numbers against 21 on the line marked B on the slide—then against 30 on the fixed part on A, will be found on the slide, \$1.10—and opposite 35 lbs. will be \$2.45 40—2.80; 50—3.50; 60—4.20; 75—5.25; 90—6.30; 100—7.00.

If 4 1-2 yds. cost \$23, what will 20 yds. ? Draw out the slide, till 23 coincides with 4 1-2 on the fixed part—then opposite 20 on the fixed part will be found \$104, on the slide—by not moving the slide at A, on the fixed part, 100 yds. will be found to the answer on the slide=\$5.11.

If 4 lbs. of sugar cost \$1.50, what will 20 lbs. ? bring 4 on the line of numbers on the fixed part, opposite \$1.50 on the line of numbers on the slide—then opposite 20 on the line of numbers, on the fixed part will be found \$7.50 on the slide—by not moving the slide opposite 40, on A is found —15.00 on the slide, and against 80, on A is found \$30, and at A, 100 lbs. on the slide, on B is found \$37.50—ABCD on the right of the scale.

To find the circumference of a circle the diameter of which is 20.

Draw out the slide till 22 on the slide coincides with 7 on the fixed part, then against 30 on the fixed part is found 62 6-7 or 61 3-4 on the slide—let the slide remain, and against 25 on the fixed part, is 78 4-7 on the slide—and against 60 on the fixed part is 183 4-7 on the slide—and against 100 at A, on the fixed part, is 314 2-7 on the slide.

If 1 yd. cost \$9.00 what will 5 16 cost ?—draw out the slide, till 9 on the slide coincides with 16 on the fixed part, then, opposite 5 on the fixed part is found on the slide \$2.83

*Examples.*

**Board Measure.** To measure a board or plank 12 feet long and 12 inches wide:—12 on the fixed part to the right of the centre 1 is reckoned 12 feet in length—but 12 on the slide gives 12 to 12, or 12 feet.

12 feet long and 19 inches wide—draw out the slide till 19 coincides with 12 on the fixed part; that makes the board 19 feet—the answer on the slide—19 inches the answer in feet.

14 feet long—20 inches wide—draw out the slide till 20 inches coincides with 12 on the fixed part, and against 14 on the fixed part, is 23 1-3 feet the answer.

22 feet long 20 inches wide—draw out the slide till 20 inches coincides with 12 on the fixed part, and against 22 on the fixed part is 36 3-4 feet on the slide, the answer.

## GUAGING.

**Illustrations.** First, find the number of cubic inches in the body, the contents can be determined in gallons, bushels, &c. by dividing the number of cubic inches in a gallon, bushels, &c. respectively. A wine gallon by which most liquors are measured, contains 231 cubic inches. A beer, ale, or milk gallon contains 282 cubic inches. A bushel of corn, malt, &c. contains 2150,4 cubic inches. This measure is subdivided into 8 gallons, each of which contains 268,8 cubic inches.

In the following rules, the dimensions of a cask is supposed to be given in inches, and decimal parts of an inch.

To find the number of gallons or bushels in a vessel of a cubic form, divide the cube of one of the sides in inches, by 231, and it gives wine gallons; divide the same cube by 282 and it gives beer gallons; and divide by 2150,4, and it gives the number of bushels the vessel will hold.

**Example.** To require the number of wine and beer gallons, also the bushels contained in a box, the sides of which is 50 inches. Multiply 50 by 50=2500 by 50=125000 divided by 231=541 1-4 gallons, wine measure; now, 125,000 by 282=443,26 gallons beer measure; again, 125,000.0 by 2150.4=58.1 bushels.

*To find the number of gallons or bushels contained in a body of a cylindrical form.*

**Illustration.** Multiply the square of the diameter of either end or base by the length of the cylinder, and divide the product by 294.12 and the quotient will be the number of wine gallons; divide the same number by 359.05, which will give

the number of beer or ale gallons; and divide the product by 2738, and the quotient will be the number of bushels.

The above numbers for divisors are found by dividing 231, 282, 2150.4, by the decimal, 7554—two cyphers are affixed in the following example to the product to equal the number of decimals in the divisor, which makes the quotient the number of gallons, but the other cyphers added to the remainder gives decimals.

*Example.* The number of gallons required in a cylinder, the diameter of its base being five feet=60 inches, and the length 13 feet=156 inches— $30 \text{ by } 60 = 3600$  by 156 = 561600, the dividend divided by 284.12 = 1979.12 answer.

*To find the number of gallons or bushels contained in a body of the form of a pyramid or cone.*

*Illustration.* Multiply the area of the base of the pyramid or cone by one third of its perpendicular height—the product divided by 231 gives the answer in wine gallons; divide by 282 gives the answer in beer measure; by 2150.4 the answer is given in bushels.

*Example.* The number of beer gallons required, contained in a pyramid, the base 30 inches square, perpendicular height 60 inches.

30 inches, side of the square base multiplied by 30=product 900 multiplied by 20 one third of the height=18000 divided by 282 inches in a beer gallon—answer 63.8.

The area of a base, whither square, triangular or circular, or any other form—multiplied by one third the perpendicular heights gives its solidity.

To find the number of gallons or bushels, contained in a vessel in the form of a frustum of a cone.

*Illustration.* Multiply the top and bottom diameters together, and to the product add one third of the square of the difference of the same diameters; then multiply this sum by the perpendicular height, and divide the product by 292.12 for wine gallons—359.05 for beer gallons: 2738 for bushels.

*Example.* To find the contents in wine gallons of a cone, the bottom of which is 40 inches, the top 30 inches, and the perpendicular height 60 inches.

Forty, bottom diameter, divided by 30, top diameter = difference 10, multiplied by 10=100 square of difference, divided by 3=33.3, one third the square. Again, 30, top diameter, multiplied by forty, bottom diameter=1200; to which add 33.3, the square: product 1233.3, multiplied by sixty, perpendicular height=73998.00 divided by 294.12, product 251.59 gallons, wine measure.



**To Gauge a Cask.—Illustration.** Measure the head diameter, and should there be any difference in the heads, add both together and divide, by 2, thus obtaining an average—measure also the diameter at the bung, taking the measure inside of the cask, then measure the length of the cask making proper allowance for the thickness of the heads—having these measures—now take the difference between the head and bung diameters, multiply this difference by 62 and add the product to the head diameter, the sum will be the mean diameter—multiply the square of this by the length of the cask, and divide the product by 204.12 for wine 359.05 for beer and by 2738 for bushels.

The decimal, 62 is commonly used by gaugers, to find the mean diameter; but if the staves are nearly straight, it would be more accurate to use 55 or less, but if on the contrary they are very curvies, 64, 65 or more should be used, but when the staves are straight, the decimal 51 may be most proper. In every case great attention should be given to the make of the cask.

**Example.** Suppose the bung diameter of a cask is 34.5 the head diameter 30.7, after allowing for the thickness of the heads—59.3 inches the length, how many wine gallons does it contain? 34.5 bung diameter, subtracted by 30.7 the head diameter—product 3.8 multiplied by the decimal, 62—

product 2.356  
30.7 head diameter.

33.056 mean do.  
33.056

These figures multiplied make 1092.699.136 { call the decimal.  
1092.67 { 67  
59.93 length on the inside.

327801  
9834030  
546335

204.12 | 645003.101 | 219.3 ans.

Gaugers use callipers in taking dimensions of casks but a common rule or a staff may be used: but a more expeditious way is by the line of numbers on Gunter's Scale, or the Sliding Rule.

**To Gauge casks by the line of numbers on the Gunter's scale or sliding rule.**

**Illustration.** Make marks on the scale, on the callipers,

at the points 17.15 and 18.95 inches and at 52.33 inches, which numbers are the square roots of 294.12, and 359.05, and of 2738 respectively—generally a brass pin is fixed on the callipers at each of these points—having your scale thus prepared—extend from 1 towards the left hand to 62, or less, if the staves be nearly straight—that extent will reach from the difference between the head and bung diameters to a number at the left hand, which number added to the head diameter, will give the mean diameter—then put one foot of the compasses on the gauge point=17.15, for wine gallons, 18.95, for beer gallons, and 52.33 for bushels—and extend the other foot of the compasses to a number denoting the mean diameter—this extent turned over twice the same way from the length of the cask, will give the number of gallons or bushels respectively.

In the preceding illustration, the extent from 1 to 62, will reach from 3.8 to 2.4 nearly, which added to 30.7 gives the mean diameter=33.1, then the extent from the gauge point, 17.15 to 33.1 turned over twice from the length 59.3 will reach to 220.9 wine gallons—to use the gauge point 18.95, the answer will be in beer gallons, or 52.33 the answer will be in bushels.

#### *Gauging casks by the sliding rule.*

*Illustration.* On the line marked D, is the gauge point marked W G where are 17.15 inches, a little to the right of the long mark, that is over the centre of G—also over A G on the same scale is 18.95 or 18 19-20 very near the long mark over the centre of G; here is the gauge point for the ale or beer gallons, as the other was for wine gallons—now set the length of the cask found on the slide against the gauge point on D, and against the mean diameter on D the answer will be found on the slide—allow for the thickness of both heads 1.1 1-2 or 2 inches in measuring the length of a cask, according to the size of the cask.

Take the head diameter close to the outside, and for small casks add 3-10 of an inch—for casks containing 30, or 40, or 50, add 4-10 inch; for larger, add 5 or 6 tenths, and the same will be very near the head diameter within. In taking the bung diameter, observe in moving the rod or staff backward and forward, if there is any variation as to the thickness of the staves opposite the bung whether some are thinner or thicker than they ought to be, in which case make the necessary allowance.

*Example.* How many gallons will a cask contain the bung diameter of which is 34.5 inches, the head diameter 30.7.

$$\begin{array}{r}
 34.5 \\
 30.7 \\
 \hline
 2 \mid 65.2 \\
 \hline
 32.6 \\
 5 \\
 \hline
 \end{array}$$

33.1 mean diameter.

Length of the cask within=59.3—now draw out the slide till 59.3 on the slide coincides with the gauge point on the girt line, for wine gallons, and against 33.1 on the girt line is found on the slide 220.9 wine gallons.

The gauge point for bushels is placed on the girt line at 13 85-1000 inches, as it would run off the rule on the right. For the points for gallons, reverse it back to the left of those points.

*Illustration.* Draw out the slide, till the length of a square box coincides with the gauge point on the girt line, opposite 13 383-1000 inches; then, against the number of inches the box is square, found on the girt line; and on the slide the number of bushels.

*Example.* Suppose a box 7.75 inches square and 30 feet in length, also beginning at 7.75 and extending to 40 inches square.

Will be found	10	13 1-2	16 3-4	24	30	37 3-4	48 1-4	60	66 2-3	73 1-3	100	104 2-3	121 1-2	140 1-2	150	208	267 1-2
Against	7.75	9	10	12	13 40	15	17	19	20	21	24 5	25	27	29	30	35	40

If the box is more than 40 inches, say 60 inches—and 20 feet long, draw out the slide to the left hand till 20 feet, the length found on the slide, coincides with the gauge point, found on the girt line, viz. 13.385 inches—then against the width of the box, namely 60 inches, found on the girt line, is found on the slide 399, calling the figures on the girt line, tens, and those on the slide will be hundreds, and thus of any other number.

Suppose a box 30 feet long from 40 to 245 inches square,  
Against 40 will be found 267 bushels.

60	598 1-2
100	1675
120	2500
150	3790
190	6000
245	9950

To find the number of bushels a cylindrical cask contains or how many bushels of timber a log will make providing it be a perfect cylinder.

*Illustration.* Draw out the slide until the gauge point, 15,001. or nearer 15,000.15, found on the girt line, shall coincide with the length of the cylinder in feet, found on the slide, then opposite the diameter of the cylinder, found on the girt line in inches, are the number of bushels, found on the slide.

*Example.* Suppose the cylinder 300 feet is laid to the gauge point—then against 7, or 70 inches for a diameter is found 6444 bushels, which is the answer on the slide.

Method for cutting off any number of cubic feet of any diameter, of round timber.

*Illustration.* Suppose the number of feet to be cut off is 3 and the diameter 7 1-2 inches—draw out the slide until 3 will coincide with 7 1-2 on the fixed part, then against the gauge point 13.54 inches is found the length to be cut off.

*Example.* If \$2.15 buy 1 foot of timber, how much will \$10 buy? Ans. 4.65 cubic feet.

This timber is 4.3 inches in diameter; what is the length of the stick?—lay 4.65 feet on the slide, opposite 4.3 inches on the girt line and opposite 13.54 inches on the girt line will be found 46.5 feet, the length of the stick on the slide.

For square timber draw out the slide so that the number of inches the stick when square, found on the fixed part, coincides with the number of feet on the slide—then against 12 is found the number of feet in length to be cut off.

The method of casting interest on the sliding rule for one year.

*Illustration.* The principle or number of dollars is found on A—put the per cent on the slide against the center 1—then opposite the principal is found the interest, estimating dollars as cents. To ascertain the interest for days find the number of days for one year, or 365, on the fixed part A, when the slide must be drawn so far that the interest for one year be found to coincide with 365 days—now on the fixed part A observe the number of days you wish to get the interest for, and under that on the slide, is found the interest for the day required.

*Examples.* What is the interest of \$33.33 for one year and twenty-five days at 6 per cent, 1st, For one year by fol-

lowing the above direction, is found \$20—then notice 365 days on A and draw out the slide till \$20 coincides with it, or under 365 days, then look for 25 days on A, and on B, under 25 will be \$1,33 1-3, the answer for 25 days.

What is the interest of \$1000 for one year and 36 days at 7 per cent.—draw out the slide till 7 on the slide coincides with the centre 1 and against 1000 on the right hand at A will be found 70 on the slide. Then lay 70 on the slide against 365 days on the fixed part and against 36 on the slide will be found \$6.88. Ans. \$76.88.

## OF STEAM.

Woolf's table, of the relative pressure per square inch, the temperature and expansibility of steam at different degrees of heat above the boiling point of water, beginning with the temperature of steam of an elastic force equal to five pounds per square inch, and extending to steam able to sustain forty pounds on the square inch.

	pounds per square inch.	Degrees of heat.		and at these respective degrees of heat steam can expand itself to about	5 times its volume and continue equal in its elasticity to the pressure of the atmosphere.
		requires to be maintained by a temperature equal to about	heat.		
Steam of an elastic force predominating over the pressure of the atmosphere upon a safety valve,	5	requires to be maintained by a temperature equal to about	227 1-2	and at these respective degrees of heat steam can expand itself to about	5
	6		230 1-4		6
	7		232 3-4		7
	8		235 1-4		8
	9		237 1-2		9
	10		239 1-2		10
	15		250 1-2		15
	20		259 1-2		20
	25		267		25
	30		273		30
	35		278		35
	40		282		40

## SOLID MEASURE OF ROUND TIMBER.

	8 ft. long	9 ft. long	10 ft. long	11 ft. long	12 ft. long	13 ft. long	14 ft. long	15 ft. long	16 ft. long
diam. in. inch.	Contents.	Contents.	Contents.	Contents.	Contents.	Contents.	Contents.	Contents.	Contents.
6	1.6	1.8	2.0	2.1	2.3	2.5	2.7	2.9	3.1
7	2.1	2.4	2.7	2.9	3.2	3.5	3.7	4.0	4.2
8	2.8	3.1	3.5	3.8	4.2	4.5	4.8	5.2	5.5
9	3.5	3.9	4.4	4.8	5.3	5.7	6.1	6.6	7.0
10	4.3	4.9	5.4	6.0	6.5	7.1	7.6	8.1	8.7
11	5.3	5.9	6.6	7.4	7.9	8.5	9.3	9.8	10.5
12	6.3	7.1	7.8	8.6	9.4	10.2	11.0	11.8	12.5
13	7.3	8.5	9.4	10.0	11.1	11.9	12.8	13.8	14.6
14	8.5	9.6	10.6	11.7	12.8	13.9	14.9	16.0	17.0
15	9.8	11.1	12.4	13.6	14.9	16.1	17.2	18.5	19.7
16	11.2	12.6	14.0	15.3	16.8	18.2	19.5	20.8	22.3
17	12.6	14.1	15.7	17.3	18.9	20.4	21.8	23.5	25.0
18	14.1	15.9	17.7	19.4	21.3	22.8	24.5	26.4	28.2
19	15.7	17.7	19.7	21.6	23.5	25.5	27.3	29.3	31.3
20	17.5	19.6	21.6	23.9	26.2	28.2	30.3	32.5	34.6
21	19.2	21.5	23.8	26.3	28.7	31.0	33.3	35.8	38.1
22	21.0	23.6	26.3	28.8	31.5	34.0	36.6	39.2	41.8
23	22.9	25.9	28.8	31.5	34.5	37.3	40.2	42.8	45.7
24	25.0	28.4	31.3	35.3	37.6	40.6	43.6	46.7	49.6
25	27.2	30.7	34.0	37.3	40.7	44.0	47.4	50.7	53.9
26	29.4	32.1	36.8	40.4	44.0	47.7	51.3	54.8	58.3
27	31.6	35.6	39.7	43.2	47.4	51.3	55.0	58.9	63.0
28	33.9	38.4	42.5	46.6	51.0	55.2	59.2	63.5	67.6
29	36.3	41.0	45.5	50.0	54.5	58.9	63.4	68.0	72.4
30	39.0	43.9	49.0	53.5	58.4	63.4	68.0	73.3	77.7
31	41.8	47.0	52.2	57.2	62.5	67.7	72.7	78.2	83.3
32	44.5	52.2	55.6	61.2	66.7	72.4	77.5	83.5	88.7
33	47.2	53.3	59.1	65.0	71.0	76.8	82.5	88.6	94.5
34	50.3	56.3	62.9	69.0	75.3	81.4	87.5	94.3	99.6
35	53.0	59.8	66.5	73.0	79.8	86.4	92.8	99.5	106.8
36	56.0	63.2	70.5	79.0	84.4	91.3	98.0	105.5	112.9
37	59.4	67.0	74.5	81.8	89.5	96.8	104.7	112.0	119.5
38	62.8	70.6	78.8	86.3	94.4	102.5	110.0	117.7	126.0
39	66.3	74.4	83.3	91.0	99.3	108.3	115.9	124.7	132.6
40	69.6	78.3	87.3	95.7	104.4	113.4	124.0	130.8	139.5

## MEASURE OF ROUND TIMBER.—Continued.

17 ft. long	18 ft. long	19 ft. long	20 ft. long	21 ft. long	22 ft. long	23 ft. long	24 ft. long	25 ft. long	26 ft. long
Contents.	Contents.	Contents.	Contents.	Contents.	Contents.	Contents.	Contents.	Contents.	Contents.
3.3	3.5	3.7	3.9	4.1	4.3	4.5	4.7	4.9	5.1
4.5	4.8	5.1	5.3	5.7	5.9	6.1	6.4	6.7	6.9
5.9	6.3	6.6	7.0	7.3	7.7	8.0	8.4	8.8	9.1
7.5	8.0	8.4	9.0	9.4	9.7	10.2	10.3	11.1	11.5
9.3	9.8	10.4	11.0	11.5	12.1	12.6	13.2	13.7	14.2
11.2	11.9	12.6	13.3	13.9	14.6	15.3	15.9	16.6	17.3
13.4	14.2	15.0	15.8	16.6	17.4	18.2	19.1	19.8	20.5
16.7	17.1	17.6	18.5	19.5	20.4	21.3	22.2	23.0	23.9
18.3	19.3	20.7	21.4	22.5	23.6	24.5	25.7	26.7	27.8
21.1	22.3	23.6	24.7	26.2	27.4	28.6	29.7	31.0	32.3
23.8	25.2	26.7	28.2	29.5	31.0	32.3	33.7	35.0	36.5
26.8	28.3	30.0	31.6	33.3	34.9	36.3	38.0	39.6	41.0
30.1	31.9	33.6	35.4	37.2	39.0	40.7	42.5	44.3	46.0
33.5	35.4	37.5	39.4	41.5	43.3	45.2	47.3	49.4	51.2
37.2	39.2	41.5	43.7	46.0	48.3	50.3	52.5	54.7	56.7
40.9	43.1	45.6	48.4	50.4	53.0	55.2	57.7	60.0	62.5
44.7	47.4	50.2	52.7	55.2	58.1	60.7	63.5	66.0	68.7
49.1	51.8	54.8	57.7	60.8	63.7	66.2	69.5	72.3	75.2
53.3	56.1	59.5	62.9	66.2	69.4	72.3	75.4	78.6	81.9
57.7	61.4	64.8	68.3	71.8	75.3	78.5	82.3	85.7	88.5
62.6	66.4	70.2	74.0	77.6	81.5	85.3	88.7	93.5	96.0
67.5	71.5	75.4	79.5	83.5	87.7	91.5	96.0	99.3	103.4
72.6	77.2	81.3	85.6	90.0	94.5	98.5	103.2	107.3	111.3
77.7	82.4	87.2	91.5	96.3	101.0	105.6	110.7	114.8	119.5
83.5	88.4	93.5	98.5	103.4	108.8	113.5	118.6	123.3	128.0
89.4	94.5	99.5	105.3	111.0	116.0	121.4	126.8	131.5	137.0
95.5	101.0	106.8	112.4	118.0	124.0	129.5	135.5	140.6	145.5
101.5	107.3	113.4	119.5	125.4	131.5	138.0	144.0	149.0	155.0
107.5	113.8	120.0	126.7	133.0	139.4	145.7	152.5	158.6	164.0
114.0	120.5	127.2	135.0	141.0	147.7	154.7	161.5	167.5	174.0
120.6	127.5	135.1	142.2	149.0	156.5	163.5	171.0	178.0	185.0
127.6	135.3	143.0	150.9	157.6	164.5	173.5	181.5	188.0	195.5
134.8	142.6	150.8	159.0	166.5	174.5	183.0	191.0	198.0	206.0
142.0	150.5	159.0	167.9	170.0	184.4	192.5	202.0	208.5	217.0
149.5	158.0	167.0	176.0	185.0	193.5	204.0	213.2	218.5	228.0

## MEASURE OF ROUND TIMBER.—Continued.

27 ft. long	28 ft. long	29 ft. long	30 ft. long	31 ft. long	32 ft. long	33 ft. long	34 ft. long	35 ft. long	36 ft. long
Contents.	Contents.	Contents.	Contents.	Contents.	Contents.	Contents.	Contents.	Contents.	Contents.
5.3	5.5	5.7	5.9	6.1	6.3	6.5	6.7	6.9	7.1
7.2	7.5	7.8	8.0	8.3	8.6	8.8	9.1	9.4	9.6
9.4	9.7	10.1	10.3	10.8	11.1	11.5	11.9	12.3	12.6
11.9	12.4	12.8	13.1	13.7	14.2	14.6	15.1	15.5	15.9
14.8	15.4	15.9	16.4	17.1	17.6	18.2	18.7	19.3	19.7
17.9	18.6	19.2	19.8	20.6	21.2	21.7	22.5	23.2	23.7
21.3	22.1	23.0	23.6	24.4	25.4	26.1	26.7	27.7	28.4
24.9	25.8	26.7	27.7	28.6	29.5	30.6	31.4	32.3	33.3
28.9	30.1	31.2	32.1	33.3	34.3	35.4	36.5	37.6	38.7
33.5	34.7	36.1	37.3	38.5	39.7	41.1	42.2	43.3	44.5
37.9	39.3	40.7	42.0	43.4	45.0	46.3	47.7	49.2	50.4
42.6	44.2	45.6	47.2	48.6	50.5	52.0	53.4	55.2	56.5
47.8	49.7	51.3	52.7	54.6	56.5	58.3	60.1	62.0	63.6
53.3	55.1	57.0	58.8	61.1	63.0	65.0	67.0	69.0	70.9
59.2	61.3	63.5	65.5	67.2	70.2	72.2	74.4	76.7	79.0
65.0	67.2	69.7	72.0	75.5	76.7	79.5	81.7	84.4	86.5
71.5	74.0	76.5	79.0	82.0	84.5	87.2	89.5	92.5	95.4
78.5	81.0	83.7	86.5	89.5	92.4	95.5	98.3	101.2	104.5
83.3	88.0	91.2	94.2	97.5	100.8	104.0	107.0	110.8	113.5
92.5	95.6	99.0	102.7	106.0	109.5	113.0	115.7	119.5	123.0
99.7	103.5	107.5	111.2	114.7	118.5	122.0	125.8	129.5	133.0
107.7	111.7	115.5	119.4	123.3	127.5	131.5	135.2	139.5	142.5
116.0	120.0	124.7	128.8	132.7	137.5	141.5	145.5	150.3	154.4
124.2	128.7	133.0	138.0	142.0	146.4	150.6	155.5	161.0	165.0
133.2	136.0	143.1	148.0	152.4	157.0	162.6	167.0	172.5	177.5
142.3	147.5	152.7	158.3	163.0	169.0	174.0	179.0	182.4	190.0
152.1	157.3	163.0	169.0	174.0	180.0	185.5	191.0	197.0	202.0
161.8	167.0	173.0	179.7	185.4	191.2	197.0	202.5	208.0	214.0
171.5	178.0	184.0	190.5	196.0	202.5	208.2	214.3	220.0	227.0
182.0	188.7	194.7	202.5	208.2	214.0	220.5	227.0	234.0	240.0
192.5	199.0	206.0	213.0	218.5	226.5	233.5	240.0	247.0	255.0
206.0	211.0	217.5	225.0	232.5	240.0	247.5	254.3	262.5	269.5
214.1	222.1	228.5	236.1	244.0	253.5	261.5	268.0	276.4	284.0
226.3	234.0	242.0	251.0	258.0	267.0	275.0	283.2	292.5	313.0
237.5	245.3	254.5	263.7	272.0	280.0	238.5	297.3	306.4	316.2



## MEASURE OF ROUND TIMBER.—Continued.

37 ft. long.	38 ft. long.	39 ft. long.	40 ft. long.	41 ft. long.	42 ft. long.	43 ft. long.	44 ft. long.	45 ft. long.	46 ft. long.
Contents.	Contents.	Contents.	Contents.	Contents.	Contents.	Contents.	Contents.	Contents.	Contents.
7.3	7.4	7.7	7.8	8.0	8.2	8.4	8.7	8.8	9.0
9.9	10.2	10.3	10.4	10.5	11.3	11.5	11.7	12.0	12.3
12.9	13.3	13.7	14.0	14.3	14.7	15.1	15.4	15.7	16.1
16.3	16.8	17.3	17.7	18.1	19.0	19.1	19.4	19.8	20.4
20.3	20.7	21.6	21.7	22.3	22.9	23.5	24.0	24.5	25.3
24.4	25.2	25.7	26.4	27.7	28.7	29.0	29.2	29.6	30.5
29.2	29.9	30.8	31.5	32.2	33.0	33.9	34.7	35.4	36.4
34.0	35.0	36.1	36.8	37.7	38.7	39.7	40.5	41.4	42.5
39.6	40.7	41.7	42.7	43.5	44.7	45.9	46.9	48.0	49.4
45.8	47.0	48.4	49.5	50.6	51.7	52.3	53.2	55.5	57.0
51.7	53.3	54.5	55.7	57.0	58.5	60.3	61.5	62.8	64.6
58.2	59.7	62.5	62.9	64.2	66.0	67.7	69.4	70.7	72.7
65.4	67.0	69.0	70.5	72.3	74.2	76.0	77.6	79.5	81.5
72.8	74.7	76.7	78.7	80.4	82.5	84.6	86.5	88.4	90.8
81.0	83.3	85.5	87.5	89.0	91.5	94.5	96.3	98.5	100.5
88.8	91.3	93.7	96.0	98.4	100.8	103.4	105.5	108.3	110.5
97.7	100.5	103.2	106.0	108.6	111.0	113.5	116.0	118.4	121.5
107.3	110.0	113.0	115.5	119.5	121.3	124.5	127.3	129.5	133.0
116.6	119.5	123.0	126.0	129.0	132.0	135.0	138.7	141.5	144.5
127.0	130.0	133.3	137.3	140.4	143.5	147.3	150.5	153.7	157.0
137.5	141.5	144.4	148.0	151.5	155.0	159.0	162.7	166.5	170.5
147.5	151.0	155.5	155.5	158.5	160.0	167.0	171.0	175.0	183.0
159.0	163.0	167.0	172.0	175.2	180.2	184.7	188.5	193.0	197.0
170.7	174.5	178.0	182.0	188.0	192.8	197.0	201.5	206.0	211.0
183.0	187.5	192.5	197.0	202.0	206.5	211.5	215.0	221.0	225.0
195.1	200.5	205.0	211.0	214.5	220.0	225.2	231.0	237.0	242.0
207.2	212.4	218.0	224.0	228.0	334.5	241.0	245.4	252.5	257.5
221.0	226.5	232.5	238.2	243.5	249.0	256.1	262.0	267.5	273.0
234.0	239.0	246.0	253.0	258.0	264.0	271.5	276.5	283.5	289.0
247.0	254.0	262.0	268.0	274.0	282.1	287.0	294.0	301.5	307.5
262.5	267.5	276.0	284.0	289.0	296.0	304.0	310.3	317.5	325.0
276.5	285.0	293.5	300.0	307.0	314.5	322.7	328.0	336.5	344.0
292.5	300.0	309.0	316.5	324.0	332.1	337.5	345.0	355.0	363.2
309.0	316.5	326.2	334.0	341.2	349.0	357.1	366.4	375.0	384.0
325.0	333.0	341.4	349.5	359.0	367.3	377.0	385.2	394.0	403.1

By the foregoing Table the solid measure of any stick of round timber, can be found at sight from 6 to 40 inches in diameter, and from 8 to 46 feet in length. It rises one inch in diameter and one foot in length at a time. The left hand column on the first page gives the inches in diameter; and the other columns the contents, which are given in cubic feet and tenths of a foot. Over the top of the columns is placed the length at the top, then the inches in diameter at the left hand column, and against it under the length, to the right will be found the contents.

### A TABLE,

Showing the rates a boat weighing with its load fifteen tons, and a wagon of the same weight, is impelled, the one on a canal and the other on a railway, which is stated in pounds and in horse power—reckoning one horse power equal to 180 pounds.

<i>Boat on a Canal.</i>			<i>Wagon on Railroad.</i>		
Miles per hour.	power in lbs.	Horse power.	power in pounds.	Horse power.	
2	33	1-5	100	1-2	
4	133	2-3	102	1-2	
6	300	1 3-4	105	1-2	
8	533	3	109	1-2	
12	1200	7	120	2-3	
16	2133	12	137	3-4	
20	3325	18	156	1	

Dr. Armstrong observes, that a horse travelling at the usual rate that wagons move, would with ease, under favourable circumstances, draw twenty tons; but Mr. Fulton says, that five tons to a horse is the average work on railways, descending at the rate of three miles per hour, and one ton upwards with the same speed.

Mr. Telford, an experienced engineer, observes, that on a railway well constructed and laid with a declivity of fifty feet in a mile, one horse will readily take down wagons containing twelve or fifteen tons, and bring back the same with four tons in them.

## TRADESMAN'S GUIDE.

The following is a list of the average weight of pipes of different diameters in the clear, with the thickness required to bear a pressure of 300 feet head of water.

Diameter in inches.	Thickness of pipe in inches	Weight per running yd.		
		cwt.	qrs.	lbs.
2	4-16	0	1	2
3	4-16	0	1	16
4	5-16	0	2	4
6	6-16	1	0	0
8	8-16	1	1	21
10	9-16	2	0	8
12	9-16	2	2	18
16	10-16	3	2	0
20	10-16	5	0	0

## CHAPTER XLI.

### *Allowances for Drafts, according to Law.*

On any quantity of	100 lbs. or	112 lbs.	1 lb.
Above 100 lbs. and not exceeding		200	2
" 200	do.	300	3
" 300	do.	1000	4
" 1000	do.	1800	7
" 1800	do.		9

Usual allowance at the Custom-House, which is considered equal to that of the law :—Sugar, Barrels, 2 lbs. do. Tierces, 4 lbs. do. Hogsheads, 7 lbs. do. Boxes, 4 lb. do. cases, 1-2 per cent. All other goods half per cent. except teas, which have the turn of the beam.


### *Allowance for Leakage and Breakage.*

Two per cent. allowed on the gauge on all merchandise.

Ten per cent. on all Beer, Ale, and Porter, in bottles.

Five per cent. on all other liquors in bottles, to be deducted from the invoice; or it shall be lawful to compute the duties by tale, at the option of the importer, at the time of entry.

### *Tares accordiag to Law, and Actual Weight.*

 Those tares not marked *actual* are according to law.

Almonds,	per cent actl.	Camphor, crude, in			
Alum, casks,	12 do do	tubs,	35	do	do
Bristles, cronstadt, 12 per cent actl.		do refined,			do
Butter,	do	Candles, boxes,	8	do	
Beef,	do	Cassia, matts,	8	do	do
Cordage, matts,	13-4 p. c. actual.	do chests, 160 lbs.	20	do	do

By the foregoing Table the solid measure of any stick of round timber, can be found at sight from 6 to 40 inches in diameter, and from 8 to 46 feet in length. It rises one inch in diameter and one foot in length at a time. The left hand column on the first page gives the inches in diameter; and the other columns the contents, which are given in cubic feet and tenths of a foot. Over the top of the columns is placed the length at the top, then the inches in diameter at the left hand column, and against it under the length, to the right will be found the contents.

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#### *Wagon on Railroad.*

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6	300	1 3-4	105	1-2
8	533	3	109	1-2
12	1200	7	120	2-3
16	2133	12	137	3-4
20	3325	18	156	1

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6	6-16	1	0	0
8	8-16	1	1	21
10	9-16	2	0	8
12	9-16	2	2	18
16	10-16	3	2	0
20	10-16	5	0	0

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### *Tares accordiag to Law, and Actual Weight.*

Those tares not marked *actual* are according to law.

Almonds,	per cent actl.	Camphor, crude, in		
Alum, casks,	12 do do	tubs,	35	do do
Bristles, cronstadt,	12 per cent actl.	do refined,		do
Butter,	do	Candles, boxes,	8	do
Beef,	do	Cassia, matts,	8	do do
Cordage, matts,	13-4 p. c. actual.	do chests, 160 lbs.	20	do do

Cinnamon, chests,		actual.	do do jars.	5	do
do mats,		do	do do casks	12	do
Cloves,		do	do Smyrna, do	12 per cent	do
Cocoa, bags,	1 per cent.		Sugar, bags or mats,	5 per cent.	
do casks,	10	do	do casks,	12	do
do ceroons,	10	do do	do boxes,	15	do
Chocolate, boxes,	10	do	do cannisters,	35	do act'l.
Coffee, bags,	2	do	Soap, boxes,	10	do
do do double,	4 lb	do	Salts, Glauber, in		
do bales,	3 per cent	do	casks,	8	do
do casks,	12	do do	Shot, in casks,	3	do
Cotton, bales,	2	do	Steel,		do
do ceroons,	6	do	Tea, Bohea, chests,	70 lbs.	
Currants, casks,	12	do do	do	12 do	36 "
Cheese, hampers			do	1-4 do	20 "
or baskets,	10	do	do Hyson, or other Green, chests		
do boxes,	20	do	70 or upwards, gross,	20 lbs.	
Copper, casks,	12	do	do Souchong, chests	80 lbs.	20 "
Candy Sugar in			do Souchong, chests	80 lbs. and	
baskets	5	do do	upwards, gross,	22 lbs.	
do Sugar in boxes	10	do do	Every box of other tea, not less		
Corks, sacks,	12 and 15 lbs.	do	than 50 lbs. nor more than 70 lbs.		
Figs, boxes,	60 lbs. 9 lbs.	actual	gross, 18 lbs.		
do half do	36	5 1-4	do		
do gr. do	15	3 1-4	On all other boxes, according to		
do drums,	10 per cent.	do	invoice, or actual weight.		
do frails,	5	do do	Twine casks, 12 per cent.		
Flour, Wheat,		do	do bales, 3	do	
Glue,		actual.	Tallow, ceroons, 10 per ct.	actual.	
Ginger,		do	do casks, 12	do	do
Gunpowder,		do	Vitriol, blue or Roman,		do
Indigo, bags or mats	3 per ct.	act'l	Venitian Red,		do
do ceroons,	10	do do	White, Paris,		do
do barrels,	12	do do	Whiting,		do
do other casks,	15	do do	Wheat of all kinds,		do
do cases,	29	do do	In some instances as stated in the		
Looking Glasses,			foregoing, the actual tares have		
French,	30 per ct.	actual.	been determined; but the packages		
Lines,		do	may vary as to their make and size;		
Lard,		do	in that case they must be weighed		
Malt, casks or kegs,	33 per ct.	act'l.	again, provided always, that when		
Nutmegs, higgers,	21 per ct.	act'l.	the original invoices of any of the		
Nails, casks,	8	do	said articles are produced at the		
Ochre, French,	12 per ct.	act'l	time of making entry of such arti-		
Pepper, bags,	2 per cent.		cles, and the tare or tares appear		
do bales,	5	do	therein, it shall be lawful for the		
do casks,	12	do	collector and naval officer, where		
Pimento, bags,	3	do	there is one, if they see fit, with		
do bales,	5	do actual	the consent of the importer, con-		
do cases,	16	do	signee, or consignees, to estimate		
Prunes,		actual.	the said tare or tares according to		
Port,		do	such invoice; but if not determined		
Raisins, Malaga,			at the time of entry, the tare or		
boxes, 6 lbs. 7 lbs.	act'l.		tares as above shall be granted or		
			allowed.		

## CHAPTER XLII.


*Abstract of Tonnage, Duties, &c.*

On American vessels six cents per ton; on French vessels one dollar per ton; and on British vessels from other places, and all other foreign vessels, two dollars per ton; fifty cents per ton, light money, if from ports to which vessels of the United States are not permitted to go and trade; but from all other ports fifty cents tonnage and fifty cents light money.

All vessels of the United States arriving from foreign ports, are subject to fifty cents per ton, unless all the officers and two-thirds of the crew are citizens of the United States.

## TARIFF OF ARTICLES.

*To be Weighed and Gauged. (Excepting Iron or articles of Iron and Steel.)*

 All articles that are subject to an ad valorem duty, are not specified in this Tariff.

Ale, beer, and porter, in bottles 20 c per gallon. do in casks 15 c do. Alum, \$2,50 per 112 lbs. Almonds, 3 c per lb. Brandy, see spirits. Bacon, 3 c per lb. Beef 2 c do. Bristles, 3 c do. Butter, 5 c do. Books printed in Latin or Greek, since the year 1775, when bound, 15 c do. do when unbound, 13 c do. do printed in English since 1775, when bound, 30 c do. do when in sheets or boards, 26 c do. Cables, tarred, 4 c per lb. Cordage, do 4 c do. do untarred, 5 c do. Camphor, crude, 8 c do refined, 12 c do. Candles, tallow, 5 c do. do wax, 6 c do. do spermaceti, 8 c do. Cassia, Chinese, 6 c do. Cinnamon, 25 c Cloves, 25 c do. Cocoa, 2 c do. Chocolate, 4 c do. Coffee, 5 c per lb. Cotton, 3 c do. Currants, 3 c do. Cheese, 9 c do. Copperas, \$2,00 per 112 lbs. Candy, Sugar, 12 c per lb. Corks, 12 c do. Coals, 6 c per bush. Figs, 3 c per lb. Fish, dried, foreign caught, \$1,00 per 112 lbs. Flour. wheat, 50 c do. Gin, see spirits. Ginger, 2 c per lb. Glass ware of cut, not specified, 3 c do. All other articles of glass, 2 c do. Glue, 5 c do Gunpowder, 8 c do. Hemp, \$4 per. ton. Hams and other bacon, 3 c per lb. Herrings, smoked, \$1,00 per. 112 lbs. Indigo, 15 c per lb. Iron, pig, 62 1-2 per 112 lbs. do round or braziers' rods, of 3-10 to 8-16 of an inch diameter, inclusive, 3 1-2 c per lb. do nails or spike rods, slit, 3 1-2 c do. do in sheets, 3 1-2 c do. do for hoops, 3 1-2 c do. do slit or rolled, for band iron, scroll iron, or casement rods, viz. one inch by 1-4, 1 1-2 by 1-8, 1 1-8 by 1-8, 3 1-2 c do. Lard, 3 c do. Lead, in pigs, bars, or sheets, 3 c do. do red or white,

dry or ground in oil, 5 c do. Looking-Glasses, 2 c do. Lines 5 c do, Molasses, 10 c per gallon. Mace, 100 c per lb. Oil, castor, 40 c per gallon. do linseed, hemp, and rapeseed, 25 c do Oil, olive, in casks, 25 c. per gallon. do. spermaceti, foreign, 25 c. do. do whale and other, 15 c. do. do of vitriol 3 c. per pound. Ochre, yellow, dry, 1 c. do. do in oil, 1 1-2 c. do. Oats, 10 c. per bushel. Potatoes, 10 c. do. Paper, folio and quarto post, all kinds, 20 c. per pound, do. do. foolscap, and all drawing and writing, 17 c. do. do printing, copperplate, and stainer's, 10 c. do. Sheathing, binder's, boxboards and wrapping paper, 3 c. do. All other kinds, 15 c. do. Packthread, untarred, 5 c. do. Pepper, 8 c. do. do Cayenne, 15 c. do. Pimento, 6 c. do. Plums, 4 c. do. Prunes 4 c. do. Pork, 2 c. do. Rum, see spirits. Raisins, Mus. 4 c. do. do in jars and boxes, 4 c. do. All others, 3 c. do. Rope, ciar or coiar, grass, 5 c. do. Spirits, from grain, 1st proof 42 c. per gallon. 2d do 45 c. do. 3d do 48 c. do. 4th do 52 c. do. 5th do 60 c. do. Above 5th proof, 75 c. do. Spirits, from other materials than grain, 1st and 2d proof 38 c. do. 3d do 42 c. do. 4th do 48 c. do. 5th do 57 c. do. Above 5th proof, 70 c. do. Sugars, brown, 3 c. per pound. do white, clayed, 4 c. do. do do powdered, 4 c. do. do lump, 10 c. do do loaf, 12 c. do. do candy, 12 c. do. Soap, 4 c. do. Snuff, 12 c. do. Salt Petre, refined, 13 c. do. Salts, Glauber, 3 c. do. do Epsom, 4 c. do. Seines, 5 c. do. Shot, 3 1-3 c. do. Steel, \$1 50 per 112 lbs. Sheet iron, 3 1-2 c. per pound. Salt, 20 c per 56 lbs. Teas, *from China*, viz: Bohea, 12 c. do. Souchong and other black, 25 c. do. Imperial, Gunpowder, and Gomee, 50 c. do. Hyson and Young Hyson, 40 c. do. Hyson Skin and other green, 28 c. do. Teas, *from any other place*, viz: Bohea, 17 c. do. Souchong, and other black; 34 c. do. Imperial, Gunpowder, and Gomee, 68 c. do. Hyson and Young Hyson, 56 c. do. Hyson Skin and other green 38 c. do. Tallow, 1 c. do. Vinegar 8 c. per gallon. Vitriol, blue or Roman 4 c. per pound. Venetian red, (Ochre) dry, 1. c. do. do ground in oil, 1 1-2 c. do. Whiskey, see spirits. Wine, Madeira, Burgundy, Champaign, Rhenish and Tokay, 100 c. per gallon. do Sherry and St. Lucar, 60 c. do. do Lisbon, Oporto and other wines of Portugal, 50 c. do. do Sicily, 50 c. do. do Teneriffe, Fayall, and other wines of the western isles, 40 c. do. do not enumerated, when impor-



ted in bottles or cases, 30 c. do. All other when imported otherwise than in bottles or cases, 15 c. do. Wares of cut glass, not specified, 3 c. per pound. White, Paris, 1 c. do. Whiting, 1 c. do. Wheat of all kinds, 25 c. per bush. Wheat Flour, 50 c. per 112 lbs. Yarns, untarred, 5 c. per pound.

NOTE. The exporter or exporters of any goods, wares or merchandise, shall give twenty-four hours notice of their intention to export; and six hours for disilled spirits.

The above duties relate to importations in American vessels. An addition of ten per cent. is imposed, if brought in foreign bottoms, excepting English, from the British United kingdoms, Sweden, Hamburg, Bremen and Lubec. Oldenburgh and Norwegian vessels, which, by treaty enjoy the same privilege as our own ships. Teas however, pay an extra duty, as will be found in the tariff.

All articles subject to duty, imported into the United States, not having been landed more than one year, are allowed a drawback of the duties (with the exception of salted and pickled Fish and Provisions, Fish Oil, Butter and Playing Cards) subject to a deduction of two and a half per cent. except spirits, which is two cents per gallon, and three per cent. on the amount of duties.

By an Assay of parts of a dollar made at the Mint it appears that 100 dollars in quarters of the ordinary circulation are worth only

100 dollars in quarters	-	-	-	-	\$94, 44
100 dollars in eights	-	-	-	-	90, 52
10 dollars in sixteenths	-	-	-	-	8, 94

Making the value of quarters about 23 1-2 cents,

Ninepenny bits 11 cents.

Sovereign fourpenny bits 5 cents.

The United States quarters (an Eagle on them) are worth 25 cents, all other quarters *as they have been called*, ninepenny and fourepenny bits as above stated—old pisteerens sixteen cents, half pisteerens eight cents.

It will be perceived by the above article that, the United States Bank has struck down our Spanish small change, and that probably all foreign coins will ultimately become supplanted with American.

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In the article on chlorine, the following article was inadvertently omitted.

Chlorine has recently been used with great success in removing animal effluvia.

A French Surgeon of great eminence has lately discovered that chlorine has the wonderful power of decomposing and destroying several of the most deadly poisons, and among others the *salive* of the mad dog.

The mode of applying it is to make a strong wash, by dissolving two table spoonfuls of the chlorulet of lime, in half a pint of water, and instantly and repeatedly bathing the parts bitten. It has proved successful within six hours after the animal has been bitten.

## ERRATA.

Page 16, 17 line from top for *compound* read *compounds*.

do. 72. 8 line from top for *temporary* read *tempering*.

do. 129, 14 line from top for *lead cotonr* read *lead colour*.

do. 262 3 line from botom for *It was* read *It is*.

do. 271 14 line from top, after *longer* read *particularly*.

do. 286, 22 line for *all those difficulties are however* read *the difficulties proceeding from errors which occur in consequence of a substitution of tares are,*

13.16  
 496  
 -----  
 826

128

325

56

64

72

144

288

144

250

20

26

2

432

10

212

432

864

1728

